THE INSTITUTION OF PRODUCTION ENGINEERS JOURNAL

THE INSTITUTION OF

PRODUCTION ENGINEERS JOURNAL

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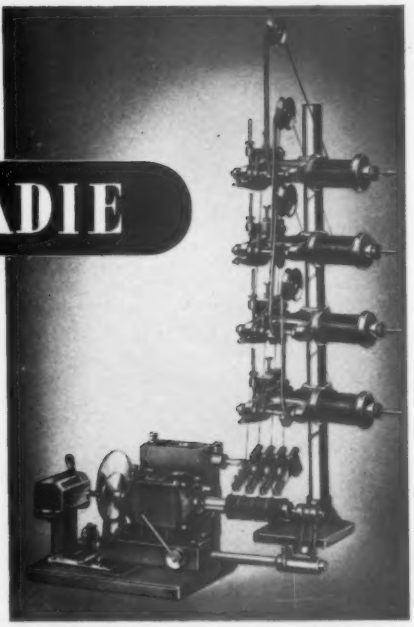

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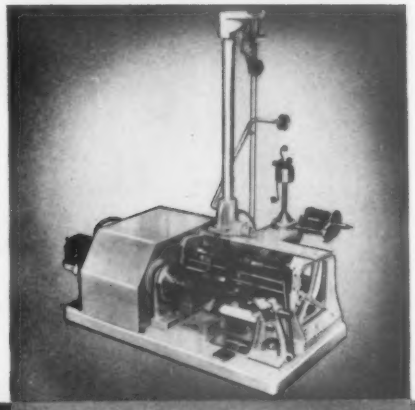

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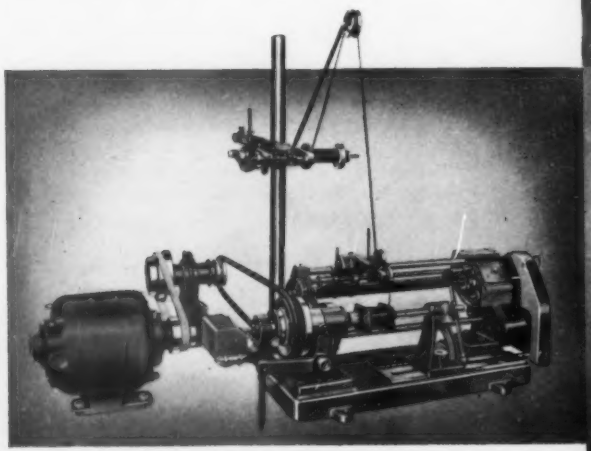

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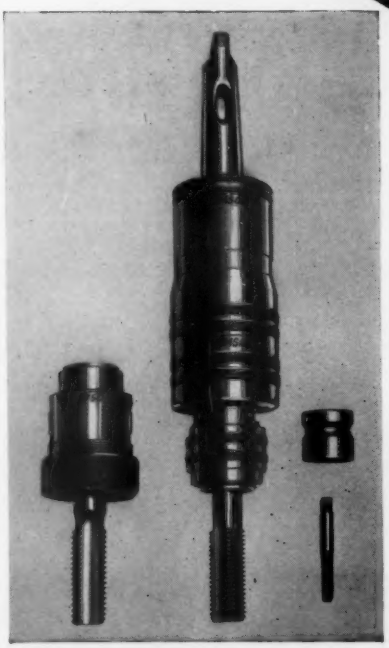

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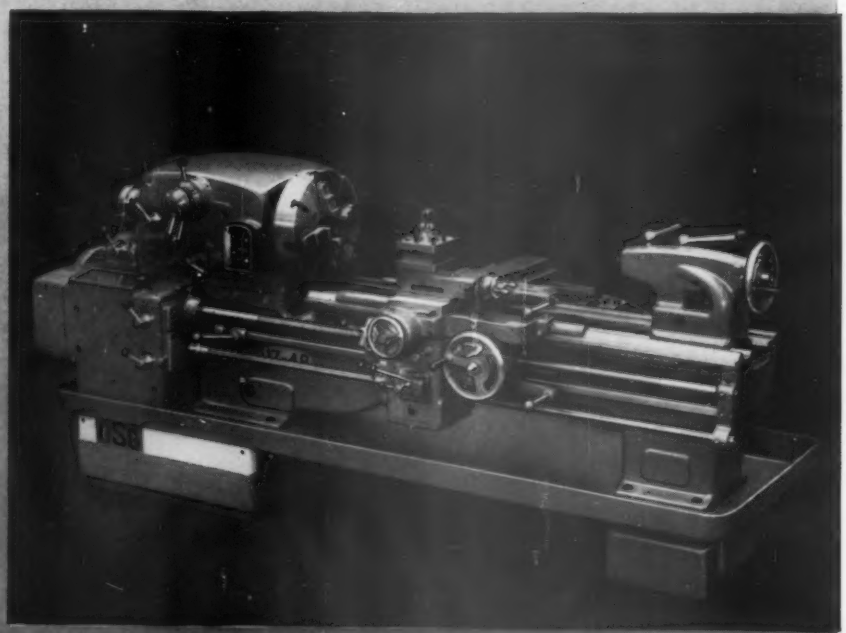

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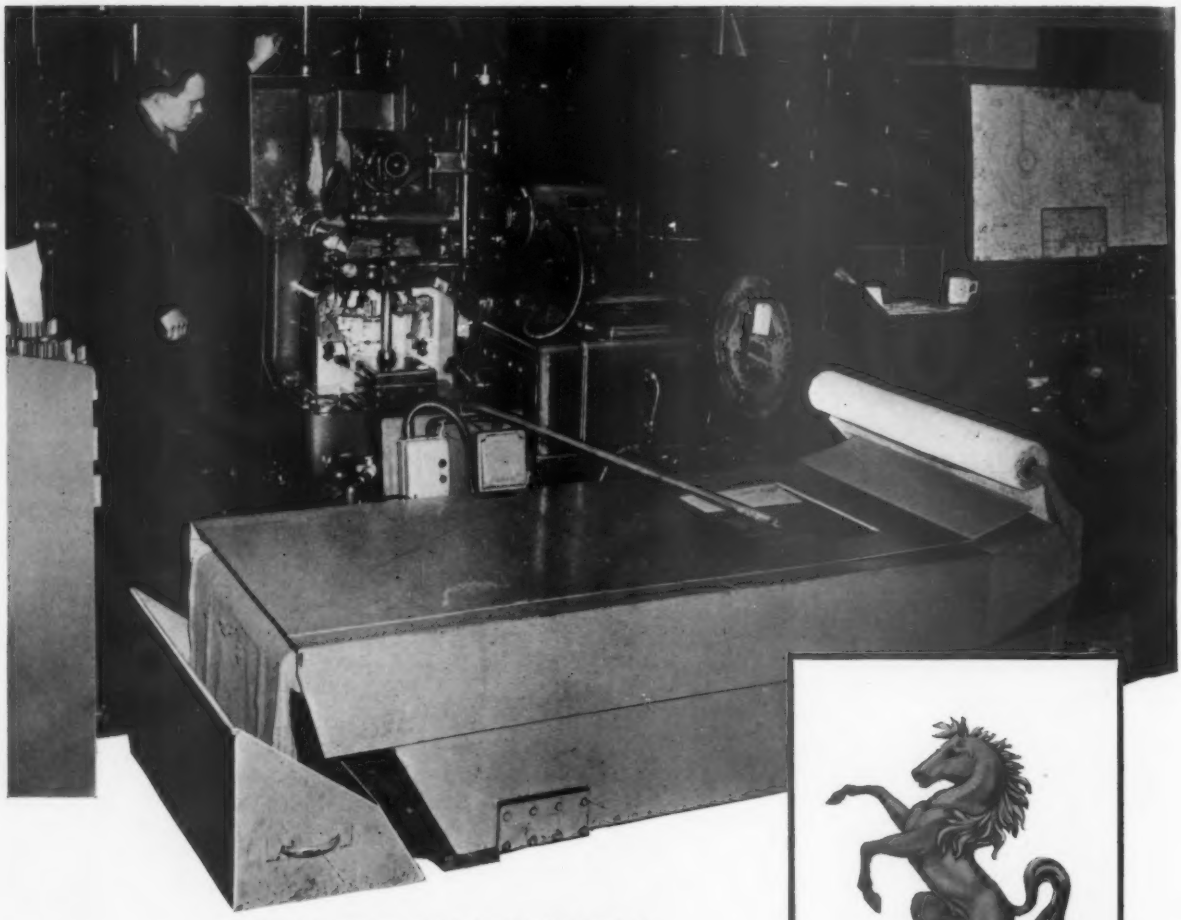

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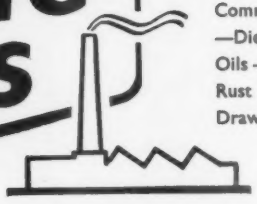

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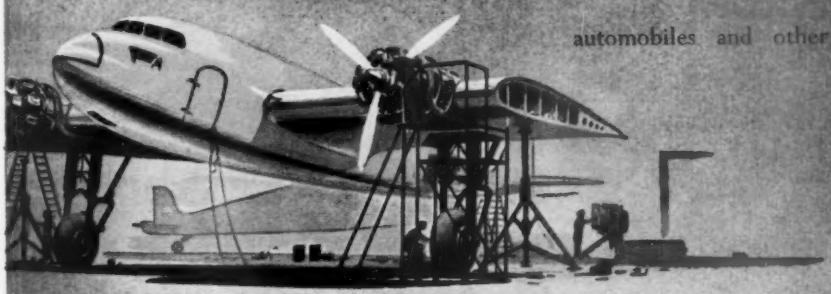

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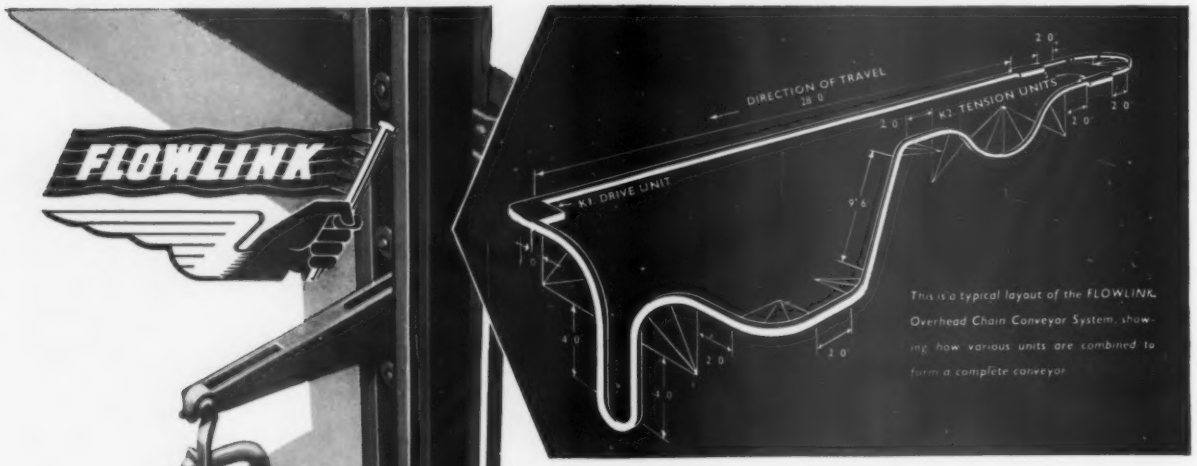
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38 0
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K2 TENSION UNITS
2 0
9'6
4 0
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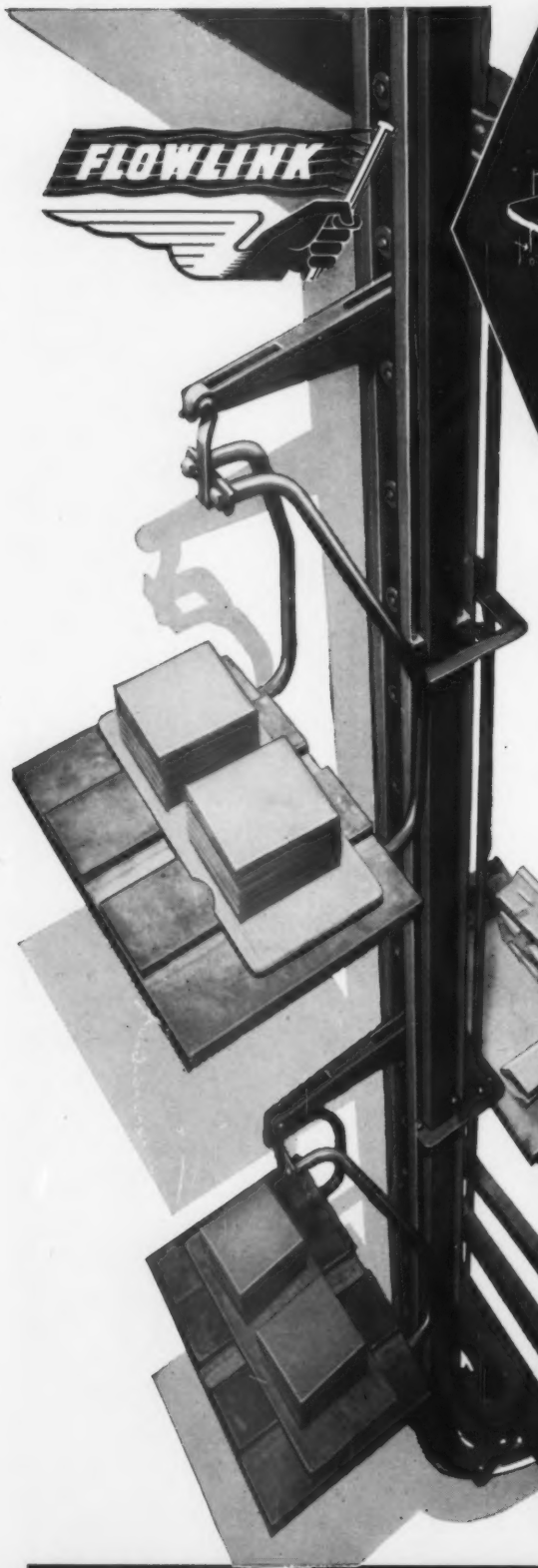

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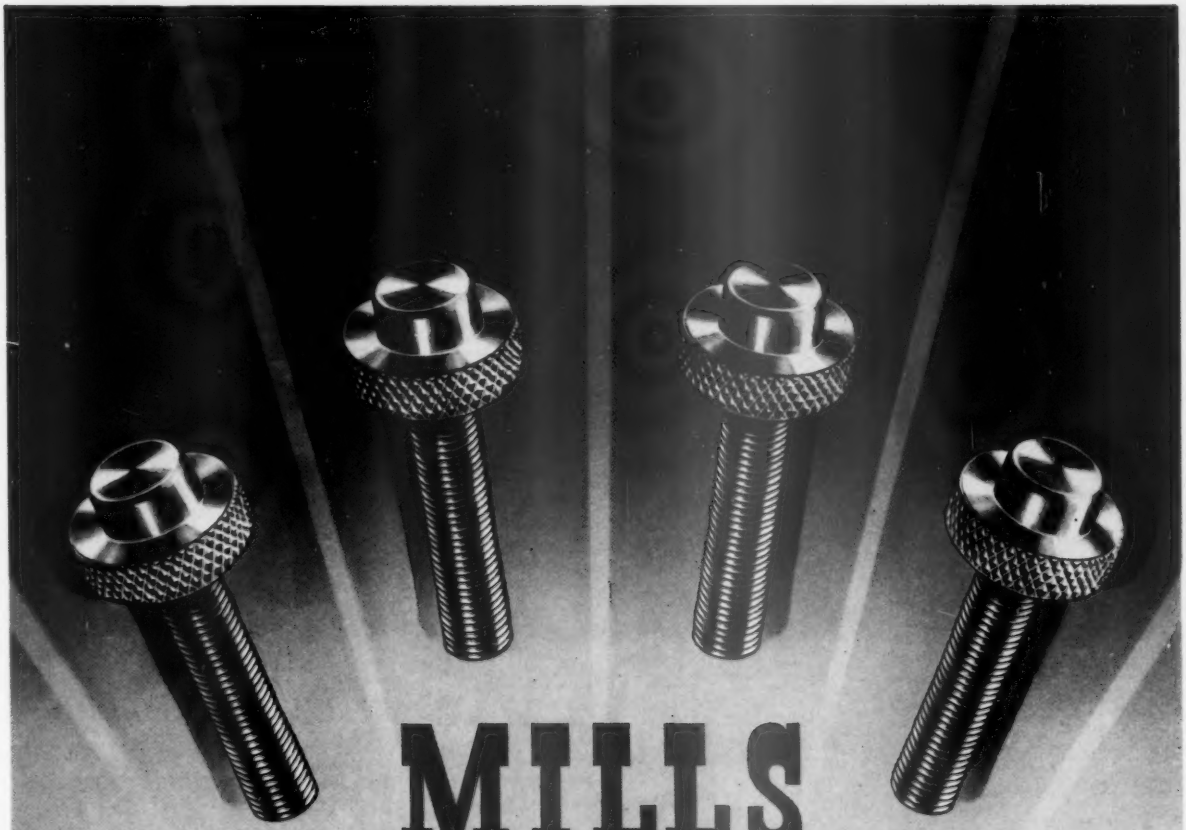

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The Institution of Production Engineers Journal
VOL. 34 NO. 2 FEBRUARY, 1955

Education and Research for Production

In proposing a toast to "The Old Centralians and The City & Guilds College" at their Annual Dinner last November, Lord Hives, C.H., M.B.E., D.Sc., Ll.D., Chairman & Joint Managing Director, Rolls-Royce, Ltd., referring to the work of production engineers, made some remarks which are extremely pertinent to the theme of the present series of leading articles in the Journal.

Lord Hives, and the Old Centralians Association, have kindly given the Institution permission to publish this address, which is reproduced herewith.

It will interest you to know that over 70 years ago our late Chief, Sir Henry Royce, attended evening classes at the old Finsbury College. He often spoke of the valuable knowledge he gained from the lectures of Professor Thompson.

Royce was one of the foremost British engineers.

He was a design genius and set ideals and standards which even to-day are used as a yardstick for quality throughout the world of engineering.

Royce deprecated the loose definition of an engineer, and it was his habit to sign himself "Henry Royce—Mechanic". You should be aware that when I refer to engineers I am using the term in the widest sense. I am conscious of the help we receive from the City and Guilds.

To-day, we specify that all the Company's Apprentices are to be prepared for the City and Guilds examinations. This decision was arrived at some time ago, after a close study of the alternatives.

When the City and Guilds of London Institute was formed in the 1870's it was in response to the many problems which had been created by the industrial and commercial "revolutions". In one of your very early memoranda it is stated that:

"After the Exhibition of 1851, it became apparent that the supremacy of Great Britain as the 'Workshop of the World' was being challenged by increasing competition from abroad. It came to be realised that the education, including technical education, of the people, and the application of scientific knowledge and artistic skill to processes of manufacture, were bound to form a part of any solution which would maintain British industrial supremacy".

It is interesting to note that after over 100 years the situation in British industry to-day is in many respects similar to that which prompted the formation of the City and Guilds of London Institute.

Present Shortage of Technologists

The present shortage of trained technicians and engineers is not a transient or temporary condition which can be attributed to armament expansion: in my opinion it is due to the simple fact that the technical component of all articles and equipment has increased, and is still increasing, at a greater rate than the output of trained technicians and engineers. It is easy to observe this in our homes. The flat iron has given way to the electric iron which has three speeds and an electric boiler built in. The drudgery of the sink and the wash-tub is gradually being overcome, and the pen or pencil we use to-day is now a highly engineered product. Similar changes have taken place in farming. The civil engineers with modern equipment can move mountains. The evolution of the motor-car is going on all the time. Recently we had automatic gearboxes, power brakes, power steering, and built-in air-conditioning, which all add to the safety and amenities of travel. There have been the enormous developments with gas turbines, both for air and industrial work.

In addition, we have hardly scratched the surface of the potential of nuclear energy and the electronic field.

We have first-hand knowledge of conditions in the U.S.A. and Canada. In those countries the demand for engineers is greater than the supply. Proposals to correct this are, however, well advanced. This also applies to other parts of the world of which we have experience.

In my opinion, we, as a nation, still lead the world in creative genius. We lag behind, however, in the application of this genius in our factories. Through the various Research Associations and through research in industry and in the Universities, we produce a staggering wealth of new ideas. In many directions, we take too long, far too long, to apply these ideas towards the manufacture in quantity of a saleable commodity and economic prices.

The structure of the British engineering industry was based on a tradition of skilled craftsmanship capable of producing a high quality article in limited quantities. There is no doubt in my mind that, to-day, the traditional skills cannot be expected to cope with the manufacture of products of ever-increasing technical complexity.

Like most problems to-day it is management which must find the answer to meet these conditions. There is no set pattern to follow and no easy solution.

I do not agree with those who hold the view that British industry, in order to compete successfully in the world market, must slavishly copy American mass-production techniques. I do say, however, that we must take a fresh look at how we can introduce into our production processes a greater degree of engineering skill.

The application to manufacturing of the findings of research requires new equipment, new materials and new techniques; and therefore requires a new outlook of management. It also requires the necessary finance to enable the most efficient plant and machinery to be used. The engineering industry must have men not only of the highest intelligence and creative ability: it must have men who, in addition, are capable of translating the discoveries of the scientist and research engineer into a practical manufactured product.

A New Field of Adventure

Production engineering appears to lack the romantic appeal which attaches to research, design and development. This is one reason why most of the more promising engineering graduates do not seek positions in the sphere of production.

This is a strange situation. Surely there is an unparallelled field of adventure for the young engineer in the application of his knowledge and inventive genius in planning the manufacture and making the idea actually "work" in the hands of the customer.

I have said that we must increase the number of engineers in our manufacturing organisations. At the same time, we must avoid depleting the ranks of research, design, and development engineers. We must avoid divorcing the production engineers from the creative designer. To accomplish this, we shall have to get greater numbers of the right type of young man to take up engineering. To paraphrase a remark made by the Duke of Edinburgh last year—"We have got to make production engineering more fashionable". That is, we must make engineering a fashionable choice of career *AT THE SCHOOL LEVEL.*

It is often said, rather forlornly, by engineers in management to-day that the cream of the schools' output is being directed towards Art courses. The important question is: what are we, as engineers, doing about it?

A Direct Approach

At Rolls-Royce, we have instituted a direct approach to the Headmasters and Careers Masters of our leading schools. These gentlemen are invited to visit our Works. They meet some of our senior officials, and see for themselves that there are knowledgeable people who are also good engineers! It also gives them an opportunity of seeing the wide range of problems in a modern factory.

I do not believe the old argument that an engineering training is too narrow, too prescribed to satisfy the inquisitive young mind. But it may have some bearing on the school boys' choice of what we may term broadly "the humanities" when he is sent up to University.

I cannot believe that the humanities offer a broader, more varied, or more stimulating field of study than can be found in the history of engineering through the ages.

This raises a question in my mind. Has sufficient stress been laid on the exhilaration that can come just as readily from, let us say, the study of the scientific or engineering investigations of Leonardo da Vinci, as can come from the study of his better-known accomplishments in the arts? The body of historical knowledge in the sciences is as extensive and as validly "classical" as the more popularly accepted subject of a classical education. The oft-heard view that the technologist's or engineer's outlook on life must, by the very nature of his training and occupation, be a narrow one angers me. I would go so far as to say that, in the context of the modern engineering industry, the engineer acquires a range of experience and requires a breadth of vision which can scarcely be equalled in any other field of endeavour.

I have seen it stated that: "If a man has an Arts degree and is also widely cultured, it is an accident of heredity". In my view, however, the fact that a man is cultured may be an accident of heredity, but that he also has *chosen* to take an Arts degree is a different matter altogether. It may be, once again, that the University courses in Engineering as presently constituted lack appeal to a young man who comes of cultured parents.

An Interesting Experiment

Now here is something of particular interest. This year, we selected several Arts graduates to put through our two-year training programme. This programme is specifically designed for engineering graduates. These Arts graduates have made outstanding progress. They rival the best engineering graduates in their grasp of the point at issue, in their alertness and enquiring approach, and in their impact on the people in the Works.

The results of this experiment reveal several things. *First*, it reveals that these young men were attracted to study the humanities, but subsequently discovered that their interests lay with a career in the engineering industry. *Second*, it reveals that the Arts courses appear to have given them a mental training which allows them to grasp technical problems and adapt themselves to engineering. *Third*, and perhaps most important, we had a much wider selection of candidates to choose from.

Present-day conditions, where engineering graduates spend a great portion of their final term in interviewing their future employers, I think is a bad thing. It tends to give them a wrong idea of values. The graduate, on entering industry, has only completed Phase I of his training. He now arrives at the most important stage of having to earn his living in competition.

We make a practice that all graduate engineers who join us, whatever their qualifications, are given a two years' course. They spend a certain amount of time in all the various sections in the factory. The purpose of this is to give them an idea of how an industrial organisation works, and what makes it "tick".

I have cited this example to illustrate my belief that if we are to produce from our Universities the sort of broad-gauge engineer which industry requires, we must give the embryo engineer something more than a narrow technological training. We must ensure that school boys are made thoroughly aware of the exciting and varied opportunities that await them as engineers in industry.

A Pressing Need

Let me stress, once again, that I am convinced that, in this highly technical age, there is a great and pressing need for men with a thorough fundamental technological knowledge in the management side of the engineering industry. A man with this fundamental knowledge *and* the necessary breadth of outlook can, and indeed must, rise to the top. The majority of the Directors and Senior Executives at Rolls-Royce are engineers and, it is my fervent hope, will always in the future be engineers, because they are most fitted to direct the policy.

I believe that the Finsbury Technical College was the first of its kind in London. The old Central Technical College was no less illustrious and The City and Guilds College stands to-day in the highest esteem in the engineering world. One has but to look at the large numbers of eminent engineers on the " Old Centralians " roster and at the distinguished guests and members here this evening to recognise the accomplishments which have been yours. There is an even greater job ahead in the field of technological education. The Old Centralians and the City and Guilds College will, I am sure, continue to play an important part.

THE CORPS OF ROYAL ELECTRICAL AND MECHANICAL ENGINEERS AND THE APPLICATION OF MODERN MANAGEMENT AND PRODUCTION TECHNIQUE

by MAJOR-GENERAL W. A. LORD, C.B., C.B.E., M.Eng., M.I.Mech.E., M.I.E.E.

Presented at the Royal Institution, 9th December, 1954.

General Lord, who was born in Birkenhead in 1902, was educated at Birkenhead Institute and Liverpool University. In 1924 he took a 1st Class Honours Degree in Engineering and two years later was awarded his Master's Degree in Engineering. He served a student apprenticeship at the Dick Kerr Works of the English Electric Company from 1924 to 1927, when he was commissioned as Lieutenant OME 4th Class in the Royal Army Ordnance Corps.

During the Second World War he served with the B.E.F. in France as CO, GHQ Troops Workshop, and later SOME, GHQ Troops. From 1940/1942 he was Chief Adviser to the Maintenance Corps of the Egyptian Army.

General Lord subsequently joined HQ 3 Corps in Persia as ADME (later upgraded to DDME), after commanding workshops in Beirut and on the Persian Gulf for short periods. Since leaving 3 Corps, then in Athens, in 1945, he has held the following appointments: President, 32 WOSB; AAG, AG21; Commandant, REME Training Centre, Arborfield; Deputy Director of Mechanical Engineering, War Office; Director of Mechanical Engineering, Middle East Land Forces; and Director, Mechanical Engineering, War Office.

General Lord

You have done me a great honour in asking me to give you a Viscount Nuffield Paper this evening. It would indeed be more correct to say that the honour is to my Corps and that, as the executive head of that Corps, it falls to me to be the spokesman. That is as I should wish it and it is in this spirit that I propose to tell you something of the history of the Corps of Royal Electrical and Mechanical Engineers, and of its achievements.

In this Paper I am handicapped by not being able to give you those figures which would give the distribution of our military and civilian manpower. Such figures, though by themselves of little importance, might enable an unfriendly power to fill in gaps in their knowledge and so lead them nearer to a pretty complete picture of the strength of our army and its deployment. This, however, I can say. By May, 1945, the strength of the Royal Electrical and Mechanical Engineers reached its maximum and was approximately 8,000 officers and 152,000 other ranks. There were, in addition, some 115,000 civilians on our pay rolls, the vast majority of these in the overseas theatres of the Middle East, Italy and India. There were the East and West African Electrical and Mechanical Engineers and, although the parent Corps exercised no direct control, there were also the Indian EME, those of the Dominions of Canada, Australia and New Zealand and the Technical Services Corps of South Africa. Another 185,000, with some 20,000 civilian employees of the Ministry of Supply, fully employed on our work in Army Auxiliary Workshops, gave a grand total of some 400,000.

To-day the organisation is smaller, but world-wide; the REME employs some 45,000 civilians and the military strength is a similar figure.

Present Day Problems

What is the task which faces my Corps to-day and what are the problems?

Its task can be simply stated as the recovery, inspection and repair of the electrical and mechanical equipment in use by the Army. There are exceptions to this wide definition, but we need not concern ourselves greatly with these for the purpose of this Paper. I might just mention one notable case. The

Royal Engineers, for example, retain a considerable repair responsibility, which includes built-in power station and refrigeration equipment and the repair of War Department operated locomotives.

Tonight we are concerned with the repair task, though in considering this we must inevitably cover a part of the inspection responsibility. Recovery, though essential and closely linked to the repair task, is not a relevant part. It can and will be ignored so far as this Paper is concerned.

I should, however, explain that to us recovery means the movement of a damaged, ditched or broken-down equipment from the place where the casualty occurred to the nearest appropriate repair facilities. Any further movement to the rear we call backloading.

It is obvious that armies exist to repel and attack enemies if the very fact of their existence fails to prevent a potential enemy resorting to force. The organisation of my Corps must, therefore, be suitable to conform with tactics in the field and the strategic deployment of forces. To comply with these requirements repairs are divided under three heads:—

1. Unit repairs
2. Field repairs
3. Base repairs

These can be described as:—

1. *Unit repairs* carried out by the tradesmen attached to each fighting and administrative unit of the Army. The range of spares carried within the unit is restricted and the tools and workshop equipment held is simple ; in general, hand tools, welding equipment and the lifting facilities of a breakdown vehicle but no lathe or power-driven tools.
2. *Field repairs* carried out by mobile and static workshops equipped with machine tools—static or on machinery lorries—and a comprehensive holding of spares including major and minor assemblies. The equipment under repair usually remains on the unit's charge and so goes back to them when completed. A high proportion of the work is carried out by assembly exchange.
3. *Base repairs* carried out in fully equipped static workshops and usually involving complete stripping and rebuilding to inspection standards devised to ensure a laid down minimum life before next overhaul. Some equipment requiring less extensive treatment inevitably finds its way back to base workshops and is brought up to the necessary condition by specified repairs determined by inspection. Output from base workshops goes into the fit stock holdings of the Royal Army Ordnance Corps.

The definitions I have given you obviously do not lay down clear-cut divisions, and in practice there is considerable flexibility. Much depends on the load at any particular moment. The Unit tradesmen—the Light Aid Detachments as we call them—can often do much more and take on tasks more appropriate to the field repair workshops, though there must be constant watch that in doing so they do not neglect their primary task of detecting and rectifying faults in the early stages of development. The field repair workshops sometimes become overloaded and the delay before they can accept a task becomes unacceptable. The Unit must be given a replacement and the repairable equipment finds its way back to the Base repair workshops.

Permissive Repair Schedules

We do prepare documents called permissive repair schedules for each item of equipment and these lay down in detail the repairs to which each type of unit should be restricted. These documents also detail the additional jobs which may be undertaken.

Do not imagine that every workshop officer goes about his task with these documents at his elbow. He does not. They are, however, his guide and the essential basis for determining the workshop equipment and range of spares which should be held by each unit in the repair organisation. Neither must it be thought that workshops are always confined to field or base repairs, though this is a desirable target.

In the United Kingdom it was the custom, before the War, for the RAOC workshops to cater for all types of repair arising within each home command. Each home command was, in fact, self-contained. The present-day principle of concentrating makes and types into batches for base repair did not fit into this geographical layout and so, although we have to-day some UK workshops concentrating on base repairs and called base workshops, others, called command workshops, have the primary responsibility of looking after the command's field repairs but, when they have spare capacity, are given base repair tasks.

All these base repair tasks within the UK are controlled by the War Office and it is here we must take cognisance of the fact that a high proportion of the British Army serves overseas—even in these days.

The aim is to make all overseas theatres self-contained for base repairs as well as unit and field repairs but if there is stringency over military manpower, shortage of local civilian labour or lack of workshop accommodation, it is base repairs which must take the brunt and this leads to the necessity to backload some equipment to UK for overhaul. This is an expensive solution which leads to heavy movement costs and very considerable additional damage in transit. It needs little imagination to realise that the use overseas of expensive skilled labour or the acceptance of the high overheads of training and organising low-grade labour is frequently well worth while. However, there is the capital cost of providing and equipping workshops. In certain cases this cost may have to be proved economical against peacetime needs, though in others the site chosen may well be foreseen as a wartime need and therefore not quite so vigorously questioned on economic grounds.

The Base Workshops

And now for something of our problems, and in dealing with these I will pay particular attention to the base workshops.

First and foremost is the vast range of equipment which has to be dealt with. Tanks, tracked, half-tracked and wheeled vehicles of every variety—there are more than 500 different makes and types in use to-day; guns, mortars, small arms and their associated optical instruments and many other optical instruments besides; wireless sets and a mass of other signalling equipment; radar and many other electronic devices which prove essential if we are to maintain superiority over our potential enemies. And we must not forget the vast range of more mundane items: laundry equipment, grass cutting machines, sewing machines and machine tools, to mention but a few. Just a word of warning over the figure 500 makes and types—many are merely specialised bodies on standard chassis.

Secondly, we face the organisational difficulties of soldiers and civilians in the same establishment. We must accept this to give us the flexibility necessary to face re-organisations and expansions in the event of war. We can neither afford, nor obtain, nor do we desire, a labour force which is 100% military. Military control is, however, necessary and so we face the difficulties of utilising soldiers and officers in control who must be trained for war and moved from unit to unit as required. In addition, we have the very same trade union problems which face you in civil life.

Planning for the Future

On top of all this we must plan for the future, for the new equipments we know are coming, even those that have barely left the drawing board. We must also look at the weapons which may be used against us and, in particular, at the atomic and thermo-nuclear bombs. I don't propose to enlarge on this point except to say that it is obvious that we must avoid concentrations or indeed units which are in themselves targets. I personally hold the view that economics and the need for dispersion are not, in our case, opposing factors. I believe that with the vast range of equipment we have to repair, the economic unit should never be bigger than 1,500 and that in most cases 600 would prove no less efficient.

I hope I have given you enough to enable you to appreciate the size and complexity of the task of my Corps. I know that quite a few of you have served in the Corps and others in other arms of the Army. Some of you may have attended the demonstration "ATLAS," which the Quartermaster General organised to show industry some of the tasks faced by the Royal Army Ordnance Corps and the Royal Electrical and Mechanical Engineers. It was there that I realised that not only were many leaders of industry staggered by the magnitude of the task and the complexity of the organisation, but that some in government service, including soldiers, were far from as well informed as I had expected.

I must, I feel, give you some idea as to how we man the military side of this organisation. It is, in fact, in this sphere that my major headaches lie. Our stated requirement is that all our young permanent regular officer recruits should have reached a minimum standard of parts A and B of the examination of the Institution of Mechanical or Electrical Engineers and should in due course qualify for Associate Membership of one of these Institutions. We are not at present getting enough of this standard and so we have a large but steadily decreasing number of short service commissioned officers. Most of these do not reach professional standard, others do, but are too old to be accepted as permanent regular officers. We have, and I hope they will always be with us, a considerable number of officers commissioned from the ranks in quartermaster type commissions. These, except in rare cases, lack professional qualifications but have a vast store of practical experience.

Coming to the other ranks, we have, firstly, the backbone of the Corps—our Armament Artificers. These NCO's and WO's—with a minimum rank of Staff Sergeant—are not only first-class tradesmen, but have that intimate knowledge of various ranges of equipment which is so vital. They are, in fact, what I understand you now refer to as technicians. Behind them are the bulk of the Corps, the regular soldiers and national servicemen of all trades, the clerks, storemen, drivers and the non-tradesmen—this last including a far from negligible person, the regimental sergeant major.

Maintaining a High Standard

You may say we have set our sights too high in insisting on such high standards. I don't hold this view. Unless we can maintain a technical standard well above that of those we advise, we fail. Still, I do not despair. I see to-day hopeful signs within Army Schools that the sixteen-year-old of to-day can produce a far higher average standard than we have seen since the War. The Army Apprentice Schools for boys, which train them as tradesmen from 15 years of age, are getting to-day a far higher standard of boy than ever before, and more of them; in fact, they are on the verge of competitive entry. The newly opened Welbeck College is attracting boys, committed to take commissions from Sandhurst in technical arms (if they make the grade), whose scientific and technical academic attainments are far above the average at Sandhurst to-day. All these boys started their serious school career after the War; they did not experience the evacuation of schools or families and though they did not avoid bombing, they were not subject to this at school. This is my explanation of what is happening, or rather was, until I talked to two Canadians, one of whom is in the audience to-night. I was told that the same decline and revival of standards had occurred in Canada where there was certainly no evacuation and no bombing. The reason, they told me, was that father and teacher had both gone to war. Well, ladies and gentlemen, whatever the reason, the result I maintain is the same and gives us all hope of setting and obtaining higher standards than we achieve to-day.

I have wandered rather far away from the title of my Paper but there are two points I wish to make before becoming more orthodox.

Change of Control

The first is the problem I referred to of facing the constant change of the officers in control. In the Army we have a system which allows a maximum tenure of appointment of three years. It has tremendous advantages and leads to organisational methods which are I know the envy of some senior executives of to-day, who experienced it during their war-time period in senior appointments. It ensures that no man is indispensable. Death, sickness, and any other temporary or permanent absence can be taken in one's stride. It is said that the Army Council reduced the normal tenure from four years—as it was pre-war—to the three of to-day because they were well aware and, in fact, had personal experience of the view that the first year was spent in deciding what the job was, the second in making a plan to correct the inaptitudes of one's predecessor, the third in producing an ideal organisation which would run on oiled wheels and the fourth in sitting back and watching it work. Why waste the last year? Let him get on with another job!.

Such a system as ours might well prove to be the answer to the problem posed by your Chairman of Council, Mr. G. R. Pryor, in his speech at your Annual Dinner, to which you so kindly invited me. As I understood him, he referred to the necessity of facing up to the fact that certain executives failed to keep pace with developments. However, it may well be that with our system of annual confidential reports—seen by the victim—we also fail. The knowledge that an individual is with you for a maximum of three years may well soften the harsh words. It has, however, the merit of preventing too many people getting into a rut; they must move on to other tasks and often find that task which best suits their limited abilities.

I must, however, tell you of a disadvantage of the three-year system which had to be dealt with rather sharply. It became almost customary for new Commanding Officers to look over their workshop and dislike the layout of their machine tools. All were smartly turned through 90° or some other angle. The effort involved was considerable, particularly as no one had had the foresight to provide alternative holding down bolts and power supplies. I hope we have cured that one.

Standardisation of Spares

My second point is a hobby horse of mine which I ride whenever I have a good opportunity. It refers to the consequences of the wide variety of makes and types of vehicles. The consequent variety of spares can be numbered in hundreds of thousands, and are not made less numerous by the apparent desire of designers to build up their own private ranges of ball and roller bearings and nuts and bolts, if nothing else. I believe that the motor industry has had fewer dealings with the British Standards Institution than any other major industry. I would suggest, however, that there are other ways out. We have to-day the British Motor Corporation and other sizeable organisations. I am no expert on the economics of the mass production of vehicles, but I cannot help but feel that some economies must result if such organisations tried really hard to build up a list of spares common to two or more, or even all, their products. And why stop there? The SMMT might produce a bigger and better spares list covering a wide field. Surely, bore diameters and hence the pistons and rings of many engines of the same type might be standardised. Even bearings and connecting rods and many items other than the nuts and bolts I originally referred to. I know I shall be accused of stifling progress and competition, but I remain unconvinced. Whatever the economies to the individual firms may be, I can assure you that the economies in manpower and money to the armed forces of this country would make a major contribution to our ability to be prepared for war.

The Repair Services

It may be putting the cart before the horse, or perhaps the horse after the cart. but I want now to spend a few minutes in outlining to you the development of the repair services of the Army. I shall inevitably stress the Royal Army Ordnance Corps element and its predecessor, the Army Ordnance Department, as it was into the engineering branch of the Royal Army Ordnance Corps that I was first commissioned. There is no thought on my part to write down the efforts of the Royal Engineers. It is, in fact, a Corps I greatly admire and whose history I study to guide me in my conduct of the affairs of the Royal Electrical and Mechanical Engineers. Nor do I wish to overlook the Royal Army Service Corps, whose experience of wheeled vehicles not only has been of great value to us, but continues to be so.

The history of equipment repair for the Army of this country is a long one and I don't propose to take you back to the days of running repairs to the armour worn by the knights who travelled so far and achieved so much, riding about on what to-day we would refer to as cart-horses. I do, however, want to make a brief reference to early 1914, when the Royal Army Ordnance Corps (the Army Ordnance Department and Army Ordnance Corps as it then was) had a small engineering branch whose primary task was the inspection and repair of guns, small arms and their associated instruments. They had also been charged with the heavy repairs to the newly introduced Motor Transport, though the supply of vehicles and their spares and their running repairs were a Royal Army Service Corps responsibility. It was the Army Service Corps in those days.

However, by January 1915, this arrangement proved unsatisfactory and the whole task was given to the Army Service Corps.

Then came that weapon—the tank. In this case an organisation was developed which led to the formation of what we now call the Royal Tank Regiment. This organisation had its own repair organisation independent of the Army Service Corps and the Army Ordnance Depot.

There were no great changes after the 1914-18 War until we came to 1925, when the repair of tracked, semi-tracked and wheeled vehicles peculiar to fighting units became the responsibility of the Royal

Army Ordnance Corps. This was closely followed by the same Corps taking over the responsibility for the repair of all other wheeled vehicles except those in Royal Army Service Corps and Royal Army Medical Corps units; these latter were RASC driven. It should be noted that these RASC driven vehicles were ordered separately, as were their spares, and that in general they were different makes. The provision, storage and issue remained an RASC responsibility.

With these changes in organisation, a number of officers transferred from the Royal Tank Corps and the Royal Army Service Corps to the engineering branch of the Royal Army Ordnance Corps.

It is, incidentally, a time at which I was first commissioned into the Royal Army Ordnance Corps as an Ordnance Mechanical Engineer. I became one of the fifty officers who at that time formed the engineering branch of that Corps. It was also a time at which its engineering branch was improved in status—its officers were no longer given quartermaster type commissions, though they did not yet achieve combatant status.

As the years went by towards the last War, there was ever increasing mechanisation of the Army and a constant increase in the officer strength of this engineering side of the Royal Army Ordnance Corps, until, by 1939, its officers numbered over 300 and, incidentally, something over 2,000 to-day. When you think of the 50 of us when I joined in 1927, you will realise that I and my contemporaries went forward on the crest of a wave. An earlier mechanisation of the Army might well have given you a different and a more competent speaker to-night.

By 1939 we had what we call light aid detachments, some 12 to 25 REME personnel, often with an officer, forming a permanent part of major mechanised units. They had proved their worth under the conditions of the Western Desert of Egypt during the Abyssinian war, when the threat of sanctions gave rise to a doubt as to Italian intentions in that part of the world.

The Formation of REME

To go on to the next re-organisation. On the outbreak of War expansion was rapid and the Army requirement for tradesmen became so large that it became a major problem. There was also a doubt as to whether all tradesmen were correctly employed or even employed at their trade at all. This problem finally led, after several committees, to the formation of the Royal Electrical and Mechanical Engineers on 1st October, 1942—days before the opening of the battle of Alamein. It was primarily the need to concentrate effort and make the best use of the country's available assets which brought this move about.

This new Corps became responsible for the recovery, inspection and repair of the mechanical and electrical equipment of the Army with certain exceptions. The Royal Engineers remained responsible for most of their engineer plant, for power stations, railways, inland water transport and certain other items. The Royal Army Service Corps remained responsible for unit and field repairs to its own vehicles, handing over its base workshops to the Royal Electrical and Mechanical Engineers and its vehicle and spares supply organisation to the Royal Army Ordnance Corps. The personnel of the Royal Electrical and Mechanical Engineers was built up by the transfer of the entire engineering branch of the Royal Army Ordnance Corps, and by the transfer of certain officers and men from the Royal Engineers and Royal Army Service Corps—there were volunteers from certain other arms.

It should be noted that at this stage each major mechanised arm still retained tradesmen of its own which it employed within its units. These, backed by the REME LAD attached, carried out unit repairs. It was not until 1952 that a further reorganisation took place, which absorbed not only these unit cap badge tradesmen into the Royal Electrical and Mechanical Engineers but the unit and field repairs workshops of the Royal Army Service Corps. This last reorganisation we refer to as REME Phase II.

I must now go back to the War days. In the early days of the War it was inevitable that the Regular and the Territorial Army officers should fill most of the appointments in the operational zones—recovery and appointments in the Divisional Corps and Army areas; leaving the static workshops to the wartime officers who had so much experience of this type of work. This division did not last for long and was never anything like so complete as my bald statement suggests. Individuals became sorted according to their merits; not all felt that their abilities had been correctly judged, but one thing was proved—many who had never worn uniform before proved admirable soldiers in the operational hurly-burly and showed an ability and zest for such a life which makes me sorry that more of them did not decide to make the Corps a career.

There was no doubt that this influx of officers did far more good than merely bringing the strength closer to the requirement. New ideas and the modification of ideas were constantly taking place. I was, myself, in Egypt in the years 1940-42, though, as you will see from the biographical note, I was something of an onlooker, as my task at that time lay with the Egyptian Army. It was amazing to see how manufacturing facilities were developed, in a non-industrial country, to deal with the shortage of spares imposed not only by a general shortage, but by the closure of the Mediterranean and the necessity to use the long route round the Cape. Many line production methods were introduced utilising low grade labour. I am told that even Bedouin women were used on engine overhaul lines and, though I never saw them, I can well believe it would work. It is, of course, true that work study and what we call modern production techniques are not a new idea. These workshops of the Middle East applied many of the principles taught to-day. It is, however, true to say that the success of any particular line depended on the ability and previous experience of the individual rather than on known and taught principles. Our efforts to-day show what you are well aware of, that management can be taught; it need not be acquired by experience, nor as an inherited characteristic.

In listing my problems I mentioned the need to employ low grade labour in many overseas theatres and I have given some indication of how the Middle East had to scrape the pot during the War. The problem is at least as difficult to-day as, though the labour requirement is less and so a higher standard can be obtained, it is still all too low for the wide range of equipments in small quantities that now has to be dealt with.

With demobilisation came a great sorting out and a fairly rapid run down in strength. Many senior and experienced war-time officers returned to their civilian jobs; so did many junior ones, though quite a few stayed. It was not long before some doubt was felt as to the efficiency of the peacetime workshops which were now such a large and important part of the Army.

The Management Training Course

A committee, or rather, a sub-committee was appointed by the Army Manpower Committee. On 19th February, 1948, their report was issued and showed that there was no cause for apprehension. The organisation was reported on as effective and efficient. There were, however, recommendations as to how improvements could be made. The following was included:—

"Though relations generally (between military and civilian operators) are harmonious, we are of the opinion that they would be improved and greater efficiency could be obtained if senior officers are instructed in the technique and appreciation of workshop management and industrial relations."

As a result of this recommendation, the Director of Mechanical Engineering at the War Office consulted with the existing training organisations, universities and the learned institutions in order to find out what facilities for management training already existed.

It was found that although there was a certain amount of this kind of training being undertaken in various parts of the country, it catered generally for a wider field of commercial and business activity than was required by the Senior Officers of REME and, very naturally, was not designed to meet the REME problem of relating the principles and practice of modern management to the particular problems and restrictions which the army officer commanding a large workshop has to face.

Planning the Course

A meeting of senior REME officers was held in July 1948 to decide upon the form that this training should take, and they reached the following decisions:—

(a) the course should be of three months' duration, subject to the experience gained on the first course; and be held at the REME Training Centre at Arborfield;

(b) the course must be conducted in close collaboration with industry;

(c) the course was to be on the discussion group principle and aim at broadening the outlook of the officers and teaching them to think along the right lines, rather than teaching them any hard and fast system of management;

(d) the directing staff of the Officers' School was to include a number of whole time high quality professional status civilians who were experts in the type of training;

(e) acknowledged experts from industry would lecture on specialised subjects such as industrial law, and industrial psychology.

A report was made upon the whole subject by an outside consultant at the request of the DME in October 1948 as a check upon the way in which War Office thinking was developing. Officers were also sent on Industrial Management courses at Nottingham and Manchester Universities and to the Henley Administrative Staff College.

By June 1949, DME was in a position to put forward concrete proposals to the Quarter-Master-General for meeting the recommendation of the manpower sub-committee. There was no substantial deviation from the recommendations made by the REME meeting of July 1948.

There was an immediate series of objections, not to the principle of the training, but to the cost and the size of the proposed establishment. It was also felt that civilian resources had not been fully exploited. There was, however, some support.

An important stage was reached during October 1949 when a meeting was held as a result of which the Treasury agreed in principle to the scheme.

A somewhat more conservative establishment was put forward in December 1949 and work on the actual syllabus went ahead. Difficulties persisted throughout 1950 but progress was made.

Two civilian experts were appointed in the Autumn of 1950 and integrated with the military staff and the first senior management course started in February, 1951, in a newly created Wing of Management Studies at the REME Officers' School, Arborfield.

The first Senior Management Course, as it was finally called, consisted of twelve officers, one Colonel and eleven Lieut.-Colonels. The duration was sixteen weeks and the frequency of courses was planned as 2-3 per year. The first course was somewhat of a pilot. One of the civilian instructors had been able to spend some time touring REME workshops, but the other was only able to receive the briefest introduction to the REME problem before the course started.

The course was built round a number of major exercises designed to exercise students in the introduction of modern methods into the REME Base Workshops of the Field Force. Each major subject or group of subjects studied was made the object of a visit to an industrial undertaking. In the initial arranging of these visits we owe a great deal to the co-operation and help given to us by your Institution; this proved to be quite invaluable. There was great emphasis on syndicate work and upon the free interchange of ideas in guided discussion.

Subsequent Modifications

Subsequent experience over two years has led us to modify our ideas somewhat. The trend has been to concentrate upon those subjects which will enable the Commanding Officer to make an effective attack upon the immediate problems of the existing base workshops, to show early improvements and savings, and to train his subordinates. This has been achieved by eliminating tactical considerations and theoretical subjects of interest value only and giving increased emphasis to work study, practical laboratory work and training techniques.

The course leads up to a critical survey of a REME workshop. Students are trained to recognise factors restricting production and to understand the techniques that are available to them for the elimination of these restrictions.

The outline syllabus of the course as it stands at present is given in Appendix "A". This syllabus received the approval without amendment of a convention of Senior Officers and old students at a Management Convention held in September of this year.

By now, vacancies on these courses are allotted to Canada, Australia, India and Pakistan, though the size of the course remains at twelve.

It is interesting to note that, in the early proposals for the course, the then DME estimated the savings which would arise from such training as we have been discussing as 1 per cent of the civilian labour wage bill, which allowed a handsome dividend from the £15,000 which was the annual cost of the training given.

This figure proved to be unduly pessimistic and a study of the position indicates that the actual savings in wages and materials is, after two years, an annual sum which runs into six figures. It is unsatisfactory, I realise, not to be more precise but in the absence of a fully comprehensive costing system and in view of the difficulty of deciding which savings are the direct result of management training, I would be laying myself wide open to attack if I quoted a figure.

There are, of course, savings from sources other than wages and materials which can be credited to management training. Examples are increased plant utilisation, reduced handling, savings in space and improved stores control allied with reduced stock holding.

These results have been achieved by the efforts of no more than 64 officers who have completed the course. Not all of these are currently employed in workshop appointments. It is, therefore, hardly surprising that the main effort has been directed to those workshops undertaking base repairs and there are some 38 of these.

Incentive Schemes

I hope it will prove possible to increase the scale of training and I certainly aim at giving this training to all regular officers at some stage in their career. However, there is some merit in progressing slowly. We do not rely on incentive schemes, and I do not foresee such schemes being introduced in the future. We have a system of ability pay, but this still leaves the weekly wage packet well below that obtainable in civilian controlled industry. Nevertheless, we can recruit and keep skilled, semi-skilled and unskilled labour. The reason, even in these days of full employment, is security of employment. It is obvious, therefore, that we must avoid redundancy at all costs. But please do not imagine that it is for this reason that training is restricted. We could do much more without meeting the bogey of redundancy.

I mentioned that I did not foresee the introduction of any incentive scheme and I feel that this should be further explained. You must remember that we do not manufacture equipment, we repair it. Moreover, the variety is enormous. As an example, from the several hundred different makes and types of vehicles I previously mentioned it is rare for a workshop to be given an annual overhaul programme including more than 100 of any one make and type. Nor is there any guarantee that the same makes and types will reappear each year in the vehicle programme of a particular workshop, though obviously this is an aim. Even these small programmes offer great scope for economies, but it is hardly surprising that I am unable to give you examples of large new layouts and permanently installed equipment similar to that in use by the car and commercial vehicle industries today. As a result of this variety, far more work study effort is applied to guns, instruments and small arms. These are items whose design changes less frequently, and so we have regular annual programmes and a measure of continuity though, even here, it is often found that the annual programme cannot reasonably be spread over the whole year and employees must be switched to other work. Under these conditions I cannot see an incentive system being introduced. I know it is maintained that any job can be broken down, recorded, and its work content evaluated. It horrifies me even to contemplate the staff required and the tons of paper they would produce when dealing with our tremendous range of constantly changing equipment.

I realise that in discarding incentive schemes so arbitrarily I lay myself wide open to criticism. I should very much like to hear what you have to say on this subject, and I could almost hope that you can persuade me that I must eat my words.

I hope that I have not in any way given you the impression that we lag behind the civilian world in the economy of our repair service. In fact we maintain that our costs are lower than most. I can quote the example of a firm which overhauls a certain item of equipment for us, through a Ministry of Supply contract, at a cost of some £350 each, excluding the cost of spares.

We also overhaul this same item; our direct labour charges—at 6s. 6d. an hour—which does allow a substantial amount for overheads—total £120 each. This is not an isolated case and this ratio of 3 to 1 frequently occurs. Though I am the first to admit that these two figures are far from being directly comparable, I do maintain that the balance in our favour must be significant.

Some Typical Studies

I now propose to describe a few typical studies made and applied. The first example I wish to describe is how the students on one of the courses produced a plan for the improvement of an existing 40 mm. Bofors AA gun overhaul line in the course of one of their exercises, thus more than paying for their course. This example is of particular interest as the labour force was entirely military.

One of our base workshops was concerned with the complete overhaul of the 40 mm. Bofors AA gun and a flow line system was in operation. Difficulties were being experienced in meeting the target production figures because:—

(a) military training and regimental duties were taking about half of the working hours;

(b) the continual changes in personnel due to postings persistently upset the line.

A detailed analysis was made of the entire situation and the following alterations were made:—

(a) the operations in the overhaul line were grouped and balanced out at 8 hours per stage, or multiples of 8 hours;

(b) a separate training section was established on which new arrivals spent two weeks and learned *two* operations before being put on the line;

(c) a training programme was drawn up and men returned to the training section after a period of production until they were capable of undertaking all the operations on the line. The training section acted as a pool of labour and stabilised the labour fluctuation on the line.

As a result of the implementation of these recommendations it has been found that:—

(a) the number of personnel on the line, including those training, has been reduced from 281 to 173, saving 108 men;

(b) the man-hours spent per equipment were reduced from 928 to 506—saving 422 man-hours per equipment at the War Office figure of 6s. 6d. per hour—£137 3s. 0d.
There were 311 equipments on the programme still to be overhauled, therefore the total saving becomes—£42,653 13s. 0d.;

(c) as a result of balancing the operation and replanning the layout, the space required has been reduced from 55,400 sq. ft. to 41,184 sq. ft.—saving—14,256 sq. ft.

A further case shows progress over a period due to a variety of studies. During 1951/52 and 1952/53 a certain base workshop had a tank overhaul task which remained steady though covering several types and involving switches of labour from one type to another. In the latter year, the increase in production was 23.7 per cent with a labour force increase of only 0.7 per cent. Figure 1 shows one of the aids produced to achieve this result. It handles a wheel weighing 189 lbs and there are 20 on each tank. Instead of two men taking six hours, one man now takes three hours and the danger of accident has been vastly reduced.

In another case, a jeep overhaul programme had only 4 months still to run on the basis of a production

Fig. 1. Refitting road wheels.

of two per day. The switch from one team one jeep to a modified line system obviously could not be accompanied by the installation of lots of equipment. In fact, some portable gantries were sited and the task was split to eight stages. The average reduction in man-hours achieved was 162 per jeep, which at 6/6d. an hour gave a saving on the remainder of the programme of £52 13s. per jeep.

Figure 2 shows the fitting of liners in an engine using the equipment supplied by the engine manufacturers. Figure 3 is a method devised which cuts the man-hours involved to less than half.

I could expand this recital to great length but for brevity give at Appendix 'B' a short list of other studies, showing the diversity of activities covered.

Future Development

It now only remains for me to say some words about the possible future and I should like to do this under several headings:—

Further reorganisations.

Further progress in the application of modern production techniques to the repair task.

The application of work study to equipments of the future.

As regards further reorganisations of my Corps, there have been many views expressed. The only point I want to make is this. With the ever-increasing complexity of modern equipment, the tendency is for the Corps to increase in size and to become an ever increasing percentage strength of the Army. This we must check, or, if we fail to check it, we must consider a split—otherwise the Corps becomes too unwieldy. Where the split should come, if it proves

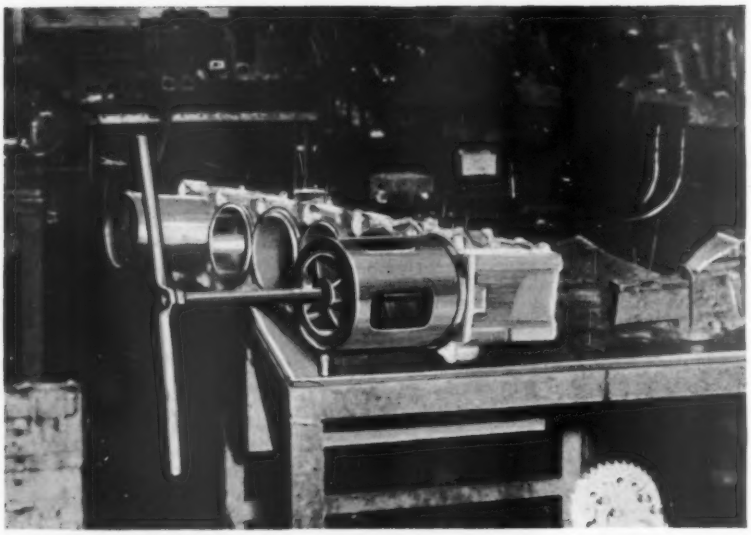


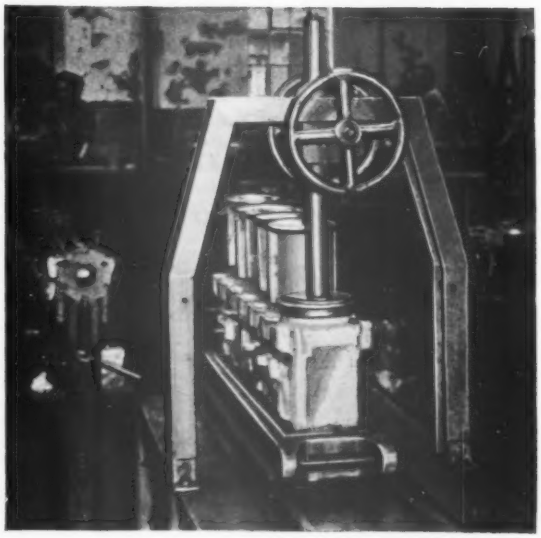
Fig. 2 (left). Fitting engine liners using manufacturers' equipment.

Fig. 3 (below). Fitting engine liners using method devised to cut man-hours involved to less than half.

necessary, is not an easy matter to decide—though the division between electrical and mechanical has been voiced. It may be a hopeless aim but I believe we must endeavour to reduce the task and hence the size of the Corps by the rationalisation of equipment and by the introduction of equipment which is easier to repair. Much can still be done in these directions.

Now, what about further progress in the application of modern production techniques? There is ample scope for progress, even in base workshops—no more than a start has been made. We must aim at training all the officers in our Corps. We must train our Armament Artificers and we must not stop at our base workshops. There is ample scope in our field repair task even in the operational areas. I was impressed a year to two ago whilst DME MELF, to see what could be done to make use of low grade labour on the task of making fit, vehicles which had suffered some deterioration by shipment or storage in the open. Instead of one team one vehicle, the men were organised in groups specialising on one task, brakes, ignition, fuel supply, body work, etc. The system relied on good inspection reports but necessity kept the skilled supervision to a very low figure. It is idle to pretend that the result was 100 per cent but a considerable production was achieved, a production far in excess of anything which had come out of the one team, one vehicle system.

How can we make equipment easier to repair? I have at the moment teams called Maintenance Advisory Groups, attached to the Ministry of Supply Design and Development Establishments. These MAG's—as we refer to them—are part of a larger establishment of mine, called the Maintenance Technique Development Establishment. The task of these small teams is to watch design and development and advise on modifications of layout, etc. which will make the repair task easier. They are a post war development and they are achieving much but they might well achieve more. If they were trained in work study methods they would undoubtedly produce more consistent results. But what about the designer? At the moment he is faced with meeting specifications—particularly those items which specify size and performance—which leave him little or nothing to play with. He is given the opportunity to state the price that must be paid for a particular requirement, but this opportunity is, in my opinion, all too seldom used. If the designer were trained in work study methods and kept constantly before him the need for easy repair, much more could be achieved, though doubtless at the cost of some of the requirements. I personally believe that it is in this direction that the most promising developments lie.



I have done my best to give a picture of what is

happening in my Corps and the way we are going. I hope that what I have said has been of interest and will lead to a vigorous discussion. I certainly invite criticism and welcome any suggestions you have to offer. I look to you for help—help which you have given so generously in the past.

May I thank you, Sir Walter, and your Institution, for asking me here to-night.

APPENDIX A

BLOCK SYLLABUS
FOR
SENIOR MANAGEMENT COURSE
HELD AT R.E.M.E. OFFICERS' SCHOOL

Periods of 40 Minutes

Serial	Subject	Lectures and discussions	Demonstrations and Films	Visits and Practical	Revision and Spare	Examinations and Tests	Administration and Leave	Total 40 min. Periods
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(j
1	Analysis of Management	23						23
2	Government Organisation and Administration	6		5				11
3	Army Organisation and Administration	5						5
4	Workshop Organisation	13		11				24
5	Financial and Cost Control	9						9
6	Presentation and Analysis of operating results	12		5				17
7	Workshop buildings and services	13						13
8	Plant Utilisation and Control	16		11				27
9	Work Study	46		32				78
10	Production Planning and Control	32		71				103
11	Stores Organisation and Control Procedure	9		11				20
12	Inspection Organisation and Control Procedure	9		10				19
13	Wage Administration	14		11				25
14	Manpower Control	19		8				27
15	Industrial Psychology	5						5
16	Industrial Law	8						8
17	Staff Duties	9						9
18	Speech Training	3		18				21
19	Exercises		128					128
20	Miscellaneous	18			60		70	148
		269	128	193	60		70	720

APPENDIX B

SUMMARY OF SOME FURTHER PROJECTS

Project	Results
Telephones	Introduction of a line system leading to the use of semi-skilled labour instead of skilled and a reduction of man-hours per telephone from 8 hours to 5½ hours.
Duplicating	A study of office duplicating leading to an annual saving of £300.
Wage payment	Introduction of an itinerant paying staff leading to a reduction in lost time of 610 hours a week per 700 employees.
Flame Thrower Repair and Test	Test and repair carried out on shop floor. Use of range discontinued. Larger safety factor, also 19 hours saved on each equipment.
Stands, Instrument	Line system introduced. Output increased forty-fold with decrease in man hours of 60 per cent.
Stands, Supporting 3.7 Transporter	Result of suggestion scheme. New type of stand designed and manufactured. Important safety factor. Award anticipated.
Jig for holding collar (rifle repair)	Result of suggestion scheme. Ingenious device for filing collar, manufactured from unserviceable rifle bolt. Award of £10.
Support for Hubs Trailer Artillery	Result of suggestion scheme. Simple stand manufactured for holding hubs of trailers artillery. Rectified an obvious planning omission.
Stands, Supporting	Stand designed to facilitate movement of switchboards during overhaul. Alleviate materials handling problem.
3.7 A.A. Mk 2 C Eqpt Chipping and Filing Gun Cradle	Time reduced from 5 hours 27 mins to 1½ hours. Reduction in fatigue of operator. Saving £200 per annum.
Welders Shop	Statistical analysis of gas used unproductively by technique of activity analysis resulted in adoption of economising apparatus. Saving of 25.4 per cent gas. Also increased plant utilisation enabled existing plant to cope. Request for more plant proved groundless.
Removing and replacing hub bearings and brake shoes. Small batches	Original time 15 mins. New Method 7 mins 13 secs Time saved 7 mins 47 secs Labour—1 semi-skilled instead of 1 skilled man
Villiers Engine Recarbonise, grind valves reassemble	Original method 67 mins New method 53 mins Saving 14 mins per unit
Shanks 24″ power Lawn Mowers. Dismantle, grind cutter, reassemble	Original method 2 men New method 1 man Same time. Heavy lifting eliminated

(This type of project can be continued at great length)

1954 VISCOUNT NUFFIELD PAPER

REPORT AND DISCUSSION

The PRESIDENT, (Sir Walter Puckey) in introducing the speaker, said he thought he detected a large number of service uniforms beneath the rather drab civilian dress he saw around him. With that in mind, there must obviously be considerable precision in starting the meeting promptly. It gave him great pleasure to welcome members of the Institution and their guests, members of the Services and civilians.

This was the second Viscount Nuffield Lecture, and it was appropriate, bearing in mind that the first one was given by an old friend of Viscount Nuffield, one of his own predecessors in office, that he should refer first to an apology from Lord Sempill, who gave the first Nuffield Lecture in that very place last year. He had to attend a Mansion House Dinner and very much regretted his inability to be present that evening.

It was hardly necessary to tell members of the Institution or, indeed guests, the purpose of the Nuffield Papers. Viscount Nuffield was a distinguished President of the Institution and he and a number of others were honoured by having Papers named after them which were read by authorities in their particular field, and usually once a year, in one or other of the Sections of the Institution.

Quite apart from his distinguished work in other fields, Viscount Nuffield did great service for the Institution as President, and set an example which many others had endeavoured to live up to. It was particularly pleasurable that he himself, in his last year of office as President, had been able to persuade —though it did not take much persuasion—Viscount Nuffield's successor in that great business, Sir Leonard Lord, to become President of the Institution and, at this moment, he was indeed President Elect.

That was all he wanted to say about the occasion, beyond adding that he thought the speaker and the subject for the evening were worthy of the occasion.

Broadening the Base

For some years past, as members would know, one of the principal planks in the Institution's platform had been the phrase "broadening the base". Nothing had given the Institution more satisfaction than the association they had had with, if he might use the short term, R.E.M.E. He well remembered the original approach made to the Institution some years ago by R.E.M.E. He remembered the enthusiasm with which they appeared to embrace the problem of encouraging modern production and management techniques within R.E.M.E. He well remembered his own personal pleasure and the pleasure of many of his colleagues when they received a great welcome down at Arborfield, and found a keen, lively, intelligent, forward-thinking bunch of chaps with whom they exchanged experiences.

It was therefore with great delight that they heard that General Lord would describe to them what had happened in R.E.M.E. over the years. It seemed to them that this was an opportunity not to be missed. It was, of course, broadening the base of the Institution in no uncertain manner. In spite of all that had been done and all R.E.M.E. had been able to accomplish, there were many people, he was afraid, who had no idea whatever of the policy and performance of R.E.M.E. in this particular field, even though they knew of it as a body in the Services. Yet in many ways, if he might say so with great respect, it was ahead of those who were in industry itself.

At one Summer School he had heard a certain civilian, who should be nameless, saying how surprised he was to find how much the R.E.M.E. chaps knew. Perhaps the R.E.M.E. fellows were surprised themselves at the ignorance of other people as to the way in which R.E.M.E. had embraced modern techniques and become forward-thinking. These were apt to be regarded as the prerogative of industry.

Importance of "Mechanised Men"

Coming down in the train from Shrewsbury that morning, the President had been reading Frank Owen's book about Lloyd George, "The Tempestuous Years", in which he described certain incidents in the Boer War. He was not suggesting that there was any connection between the Boer War and R.E.M.E. But during one part of the Boer War, the War Office was obviously experiencing considerable difficulty. The Boers had developed their guerrilla tactics to a considerable extent, and were turning up in unexpected places and harassing the British Army. Yet during the whole of this period and for some time afterwards, the War Office persisted in stating their requirements as "unmounted men preferred". It seemed a long time, as far as one could understand, before they realised that mounted men might be preferable. To take a modern simile, one might say, speaking as a civilian, that before the last war they were still calling for "unmechanised men preferably". Certainly one could see to-day that mechanised men were very much to be preferred. It would be realised from the printed Paper that a great deal had been done and that a great deal more had to be done.

He hoped to learn more about these things and he was delighted to welcome General Lord. It was hardly necessary to read the long list of his qualifications. It was sufficient to say that his present position as Director of Mechanical Engineering, War Office, was an indication of the authority with which he would speak on this most important and enthralling subject. He had very much pleasure in calling upon General Lord to present his paper.

(*General Lord's Paper appears on pages 68 to 78*).

Mr. K. J. Hume (*Principal, National College of Horology and Chairman of the Institution's Papers Committee*), said that it gave him great pleasure to open the discussion and to congratulate General Lord on his very interesting Paper in a field with which many of those present were not very familiar. No doubt there were others who would be more competent to open the discussion both as regarded the technical aspects of management study and the service aspects. He had not had the privilege himself of serving in the Services, except as a part-time soldier in the Home Guard.

He would like to comment on one or two aspects of General Lord's Paper; in particular, the educational details he had given. That aspect had not been emphasised in his talk, but in his written Paper a considerable proportion of space was devoted to it and to showing the extent to which his job and the job of his Corps had depended on systematic and thorough training. Although a lot of training at most levels was done in industry, it would be well to adopt the army system, with modifications, perhaps, to a greater extent and to go in more for organised training.

There was still, perhaps, too much of the cut-and-try method in industry. People with new problems to face in all sorts of units and organisations had to get used to them individually, whereas a certain amount of concentrated training at various levels, even up to management levels, as General Lord had suggested, could do a lot of good.

Perhaps his suggestion of three years' tenure of posts might have something to commend it, although with modern rates of expansion in industry during and since the War, that had been applied to a considerable extent already.

Another lesson that one might learn was simplicity. He was very much impressed by the photograph in the Paper of the very simple device for refitting road wheels. It seemed too simple to think about, but obviously it saved a lot of time and temper in doing a job with a heavy wheel. Everyone knew what sort of job that could be, even on an ordinary small car.

Many people would sympathise with General Lord's remarks about easy maintenance. The first time he himself set about changing the oil filter of his post-war car, he estimated half-an-hour. It took about two hours, just because of the position of the filter and the awkwardness of undoing the bolts. One could not get at some of them, and one had to spring the clips and then, of course, one could not get them back again. It was that sort of thing that caused enormous difficulty in servicing, particularly in the field and under the stress of war-time conditions.

General Lord said he had a hobby horse. He had touched on one of his (Mr. Hume's), and this was shown in his Block Syllabus subjects. It was significant that speech training occupied a fair number of hours in the course. One of the problems that faced industry to-day, particularly, perhaps, in production engineering—with its practical side and its intensive technical training—was the tendency to push to one side some of the subjects which were equally important. One of these was speech training—the study of English, self-expression. He considered that this was as important as any one, or perhaps two, technical subjects. So many of the young men who were doing an apprenticeship and taking their National or Higher National Certificate, when they came to the end, found from bitter experience that they had still a long way to go in self-expression, both written and spoken. Great difficulty beset the man who had a good technical training, but had neglected his English and studies of that nature. Undoubtedly clear expression in writing and speech led to clear thinking and helped with technical problems.

He hoped that subsequent speakers would be able to contribute to a more technical discussion of the paper and perhaps ask General Lord some technical questions on his comments.

General Lord thanked Mr. Hume for his flattering suggestion that industry might copy the training methods of the Army. R.E.M.E. certainly did a lot of training. With regard to speech training, it was always said that if one could not speak after a few years as an officer in the Army, it was a pretty poor show, because from the word "Go" one had tot alk to and train one's platoon.

Lieutenant-Colonel A. W. Page, M.B.E., T.D., said that one subject had been skipped over, if he might say so, and that was spares. He felt that an organisation like R.E.M.E. must be like the first team in football. It was only as strong as its reserves. Unless there was some really good organisation for spares, a lot of the good effort that went into planning the workshops would fall to the ground. His Army experience in the Middle East, Sicily, Italy and Germany showed him that spares were dealt with sectionally. *i.e.* by R.E., R.A.O.C., R.A.S.C. There was a great deal of duplication. He wondered whether General Lord could say whether spares were being integrated as a base organisation to cover the whole of the Army and all the Arms. There might be some very difficult problems of which he was not aware.

General Lord, after confirming that Colonel Page was referring to the war years, said that the base workshops as well as the field workshops, each had a R.A.O.C. store section attached. It must be remembered, too, that it was the task of his own Corps to say what those sections would hold, although it was the R.A.O.C. task to supply them and to run them insofar as accounting procedure and so on was concerned. The C.O. of the workshop said what was to be held, the original holding being based on scales produced by the R.E.M.E. Scales Branch. There had therefore been some progress since the period to which Colonel Page had referred.

Captain (E.) Cristopher Jones (*Royal Navy*) said that he felt a little lonely amongst so many army officers, so perhaps it would be a good idea to move into the attack right away. He too was in the Middle East in the early stages of the War in 1940, and so far as he remembered, the Eighth Army Corps (he

thought that was the Corps) believed that if one put the correct fluids in the proper holes the thing went on for ever. They found that was not quite right, and the first tank repair workshop was started in Alexandria with the assistance of the Royal Navy, who provided the first ratings and officers to man this unit. However, that was only a minor incident, because when the Army got into its stride, the enormous number of people they produced to do this work in a remarkably short space of time completely amazed him.

Some things were bound to be comparable between the Services, and General Lord had gone over most of the problems the Navy had come up against. First, there was the training of officers; and here he must take the lead from his Senior Officer, and disclaim right away that anything he might say should be regarded as in any way expressing the opinion of My Lords! The Navy also trained officers in management, and the Royal Naval Engineering College did a certain amount of management training. But it was not nearly adequate when they came to workshops which included civilians. This problem had been of interest for a number of years and as yet a good solution had not been found.

Outside courses had been tried, and he hoped the industrial people present would not think it rude of him if he said that about half of the courses included elementary stuff in respect of man management which naval people learnt when they were very young. It was in other subjects, such as work study, that they learned a great deal. They also found that the middle management were not very well trained. The solution to that had not been found, either. Various courses for middle management throughout the country did not appear to be up to the required standard, so the Navy were trying to set up their own college, which would not be so advanced as General Lord's. It might provide teaching for supervisors, foremen and middle management.

General Lord had explained how R.E.M.E. had overcome the difficulty of employing civilian and uniformed workmen in the same shops. Only the other day he was asked by a distinguished Admiral how one managed to get civilians to work alongside uniformed people, especially at different rates of pay and in different conditions, and so on. He had explained to the Admiral that during the War there was a radio workshop in which there were R.A.F. personnel, naval male personnel, WRNS, civilian men and civilian women. The whole thing was run by a very "blue-stocking" but extremely feminine and beautiful 'Wren.' It ran extremely well. He had never heard her raise her voice—scarcely above a whisper. It was perfectly simple, the Admiral said, to see why the workshop ran well—"They united against you, the common enemy."

Incentive schemes were used in naval establishments where aircraft repair work was carried out. One might think it was extremely difficult to rate repair work, but it was not all that difficult, although the ratefixing was not as good as one would like. It might be due to the difficulty of getting adequate ratefixing planners and preventing the constant upward movement which came from union pressure. Nevertheless, it did work quite well.

This led to the question of cost. The naval establishments, particularly in repairing aircraft, did carry out repairs at a cost that was at least equal to that in industry; that was to say, the cost the service paid industry. They had never been able to find out what it really cost industry to do the job. They would not say!

With regard to tenure of the job, it was found preferable, particularly in civilian establishments, to have naval officers for the higher management. This was frequently criticised, but it was the only way. With an entirely civilian establishment, there was continual deviation away from the *raison d'être* of the establishment. If the higher management were naval officers, it was constantly evident to everyone in the place that the establishment was for service purposes, not to provide someone with a job at a high wage. It visibly showed the reason for the existence of the establishment and kept constantly before the workpeople their purpose in life.

Tenure of appointment had received a great deal of consideration, but the scope of the officers was different from that in R.E.M.E. They might have to look after aircraft, or act as engineer officer of a ship, or run a civilian establishment. They tried to fit into the career structure the principle that people who were appointed to the workshops would return to them. Two appointments in workshops were expected, say, before the chap eventually became the head man in a workshop with about 2,000 civilian employees. The first appointment, it was thought, should be just over two years, the second perhaps two to three years. The really vital requirement was that the head man should stay a long time.

He thought it was true to say that in industry no man who was any good ever stayed in one job for more than two or three years, so the criticisms of industry about tenure of office in the Services could not be accepted. It was only those who were not so good who stayed a long time in the job. After the middle forties, however, it was a different story. There was longer tenure of appointment in the more important jobs.

General Lord said that he remembered the naval ratings. They stayed a long time and gave very valuable service.

He agreed entirely with Captain Jones and would even go further on the subject of the man who thought he had only to put in oil and water and the thing would run for ever. Much of the problem would be solved if one could only get a really good standard of driver. Unfortunately, the driver of a wheeled vehicle was selected from the lowest intelligence ratings in the whole of the National Service intake. He told of the Brigadier who took the first Brigade to Korea. He was given load carrying vehicles which were rebuilds and he forecast that he was going to have grave difficulties over supplies. What he did not realise was that he had also by chance been given reservist drivers who were all long-distance lorry and bus-drivers. They kept these old vehicles going for a year or so without any difficulty at all.

Mr. G. R. Pryor (*Chairman of Council*), remarked that General Lord had paid tribute very generously to what his Corps had learned from industry. Industry itself must admit that there were certain things—quite a number of them—that it could learn from what had been said that evening.

There were two or three things he would beg General Lord not to copy from industry. One was incentive schemes, as they were generally understood. They were, to begin with, quite unethical. There was no equity whatever in rewarding mere manual dexterity and ignoring other attributes which were of much more value. The other thing was the introduction of costing systems. This was for quite a different reason. If General Lord though he could produce anything at 6s. 6d. an hour, an awful shock was coming to him!

General Lord agreed that the situation was not strictly comparable. It was difficult to arrive at truly comparable figures, but he still believed that there was a balance on the side of R.E.M.E. There was certainly a saving to the taxpayer.

Mr. Legarde said he had read General Lord's curriculum with great interest. He noticed that the officers who went to the School were all Lieutenant-Colonels or Colonels. Would it not be more practical if some of them had the rank of Captain?

The poor workshop officers and captains and majors generally had to run their workshops efficiently and well. If before taking up appointment they could attend a course run by the School, it would help them a lot. As a one-time officer, he felt it would have done him a lot of good. In time the Corps would have at its disposal a number of junior officers who had been trained in production engineering. He would like to see a course for junior officers.

General Lord said he was very glad that this point had been raised. He would explain exactly why they started with the senior officers. A large number of the base workshops were commanded by officers with the rank of Colonel or Lieutenant-Colonel. It was felt that the maximum results would be obtained if the C.O. were trained. If there were a junior officer with high falutin' ideas, he would probably not have got any further.

There was no question that they must get down as soon as they could to the major and captain. It would take some time, because the rate of training was low. It was less than the twelve per course that he had mentioned, because they were now committed to giving certain vacancies not only to other arms but to people from India, Pakistan and so on. The net output was probably less than ten.

A series of short courses lasting a few weeks was run for junior people, but it was felt essential to get the C.O. trained first so that he could get something going quickly.

Mr. H. Peter Jost (*Member; Director, Trier Bros.*) said he was proud and honoured to have been associated with all the Senior Management Courses at Arborfield. He was of the considered opinion that these courses, if not the best, were certainly among the very best courses on Production Management in this country.

The four months' full-time period which the senior officers spent at Arborfield was a most profitable experience, and wonderful practical training for all concerned.

It was in many ways a great pity that industry was not fully aware of the work being done at Arborfield.

Might it not be a good idea if industrialists, particularly in the very large undertakings, would consider whether it was not in the best interests of their own companies and industries to take senior executives out of their work for a similar period of four months, and subject them to a similar training? The great difficulty, of course, in industry was—and this was where the Army scored over industry—that once an executive had reached a senior position, it was assumed —at least, by himself—that he could not be spared from his duties for as long a period as four months. Nevertheless, in the case of the largest firms, it might be an economical and profitable proposition to consider similar schemes.

A considerable proportion of the Arborfield courses was spent in planning, and he wondered, as a mere civilian, whether this planning could not be extended to the planning of subsequent postings of the students by the War Office. He had known courses in which between six and nine out of twelve officers taking this excellent course, were posted to War Office staff or other non-workshop duties. Could the planning not be extended to cover the two or three years' duties of the officers immediately after a course ? The newly acquired knowledge could then be applied immediately by at least the majority of the officers attending the Course.

There was one other point. He had spent many evenings with the senior officers at the Course. He found, in talking to them, that their production engineering interests were generally infinitely greater than their interests in mechanical engineering. These interests and their activities were, in fact, closely allied to modern production engineering in its broadest sense, for which the Institution stood. The officers' work was much more closely concerned with the practical aspects of production engineering than with mechanical engineering matters.

He wondered whether the contact between the Corps and the Institution of Production Engineers, and, in fact, production engineering as such, could not be extended, for instance by making corporate membership of the Institution of Production Engineers an additional qualification for a commission in R.E.M.E. This was particularly so, as the Senior Management Course taught, and the officers in their duties as managers of workshops required, all those things for which the Institution stood.

General Lord thanked Mr. Jost for his kind

remarks. As to the War Office, the Quarter Master General was a great enthusiast on the subject, and he had made very considerable efforts to get the idea established. He had succeeded at any rate in getting one officer appointed (he did not happen to be a R.E.M.E. officer)—in a staff job in the War Office to pursue the matter and its application not only to R.E.M.E. but to other Corps within the Army. So far there had been no results. The officer was still being trained, not at the R.E.M.E. School, but by the I.C.I.

There would be some difficulty, he thought, in training the senior civilian executive. So far as the senior officer was concerned, if he (General Lord) said he was to go to the School, he went. It might be regarded as a slur on his ability if the senior executive were told to take management training. That might well be a factor in the problem.

On the other hand, he did not always have to tell people to go. Quite a lot of them came and said they wanted to go. There were times, however, when he found afterwards that they were thinking of retiring and thought it might improve their value on the market!

The President said that the tribute to R.E.M.E. paid by the last speaker would be a good note on which to finish. The late hour made it necessary, in any case, to bring the proceedings to a close, but written contributions to the discussion would be welcome.

With such a widely varying audience, he had not the courage to spend much time in summing up, but there were one or two points that had impressed themselves upon him, and were worth emphasising.

First, he was struck by the great complexity of the R.E.M.E. set-up. As a civilian, there were times when he felt strongly that it was very much more complex than one was accustomed to or would like to manage in one's own industrial concern.

During the war up to 400,000 people were employed and now there were about 90,000 comprising military and civilians. This was a pretty sizeable organisation by any industrial standard, and it was complex because it had several features that were not present in industry. To begin with, there was the division between military and civilian personnel. He had always marvelled at the way in which these people got on together. He was not sure whether the naval example quoted did not explain the reason! But they did get on, and it was impressive to see how well the services worked side by side, with civilians.

Then there was the very considerable problem of "other regimental duties". Mr. Jost was right to point out that it was difficult to spare senior men when they had reached a certain degree of responsibility. In the services, they must be spared for many things —not only for this course but for other essential duties. This made for added complexity.

Short service was another problem. Industry grumbled a lot because many young fellows had to go into the services. Again, in relation to short service, he had been interested to hear General Lord refer to Mr. Pryor's speech at the Annual Dinner and the question of knowing what to do with people. He referred to the peak of usefulness being reached in three years, the fourth year being spent in sitting down comfortably watching the results of the previous three years. He could not but feel that this was a happy omen for the Institution. Mr. Pryor was in his third year as either Vice-Chairman or Chairman of Council. He looked forward to next year when Mr. Pryor would sit back in a comfortable position and watch the Institution roll on as a result of his previous three years. Next year would indeed be a happy year !

The next thing that struck him was the complexity of the technical task. For instance, the units were widely dispersed and that created tremendous difficulty. Then the workshops were of varying sizes from 600 to 3,000. He was interested to hear General Lord's comments on optimum size. This was a subject people in industry talked a lot about but they never seemed to come to any agreement. The existence of small and large units in the same organisation was not conducive to simplicity.

There was a great variety of tasks—mechanical, electrical, electronic and all the other technical problems that had to be faced, and these problems, whether in the services or in industry, would not get less but would increase.

Again, a great amount of training had to be undergone. He was struck by the very small dent General Lord and his associates had so far made in their training programme.

Several speakers had commented on the need for more training, and it was very impressive to hear General Lord say he had only just begun to tackle the problem, even in connection with the more senior officers, and that training must be carried right down the scale to majors, captains and N.C.O.'s, whom he described as the backbone of the Corps.

One certainly sympathised with him in his very complicated task, although he hoped, following Mr. Pryor's remark about costs, and General Lord's own remarks about statistics, that we would not see the beginning of a Corps of Mechanised Accountants.

General Lord's statement that more promising young fellows were coming forward now was interesting. This was a matter that vitally affected industry, as was the use of skill in industry. It was obvious that the services had the same tasks as industry in this direction. It was a very happy omen for industry that there were more brighter boys coming along with higher technical standards. He thought everybody in industry would be glad to hear these views.

General Lord had made a plea for greater standardisation, particularly in the motor industry. It was surprising that no one had taken that point further. Perhaps lack of time was responsible. Undoubtedly, standardisation was a problem that had been hammered out over the years, and yet how much more there was to do! When one saw the end results in terms of the repair problem all over the world, one realised how much force lay behind the argument and how much more attention industry should devote to this particular problem.

Finally, he was very much impressed by the suggestion that we should "design for repair". He remembered attending a conference on aircraft production when a leading designer, now the managing director of an aircraft company, made much the same point when he suggested that we "design for modification"! That was not so silly as it might sound. He had thought at the time that it was becoming extremely difficult for designers to know what to design for. They had been told to design for production, to design for export, to design for modification and now to design for repair, not only under first-class conditions but under all the diverse and difficult conditions which R.E.M.E. and other services had to face during the course of their work all over the world.

General Lord had said that "no man was indispensable." At this moment there was one man who was indispensable, and that was someone to propose a vote of thanks to General Lord. He would ask General Appleyard, a Past President of the Institution, formally to move a vote of thanks.

General K. C. Appleyard, C.B.E., said that for over thirty years he had been a cross between a civilian and a soldier, and he was glad to say, as such, that a Paper of the kind that had been presented was badly needed.

It was a good thing that those in civilian life should understand something of the complications that the technical branches of the Army and, indeed, the Army as a whole had to face. He had seen a great deal of the organisation of the three services, and he was amazed at its beauty. It took a great deal of beating for the particular job it had to do. It was a fantastic job and nobody in industry would begin to know how to go about it without a lot of experience. If one had one of these great machines—the Navy, the Army or the Air Force—at one's disposal and something had to be done and it was agreed that it should be done, a magnificent organisation was set to work and made sure that it was done smoothly and efficiently.

It was his happy task to propose a vote of thanks to General Lord, and he did so with greater pleasure in that he also had been to Arborfield. He wished he could offer General Lord even half as good a welcome as he himself received at Arborfield, together with his colleagues who went there. They even played his own Corps march as they left the dining room, a very delicate compliment.

He wished he could feel that they were going to offer General Lord the abundant hospitality, both solid and liquid, that many of them had had at Arborfield. At any rate they were going to do their best!

They were proud as an Institution that General Lord had come to them, and they were proud that so many of his officers were members of the Institution. They wanted to see more of them, and hoped they would send their contributions to the discussion in writing.

On behalf of the Institution as a whole, therefore, he thanked General Lord for presenting his Paper and expressed the hope that he would come again.

The vote of thanks was carried by acclamation, and the proceedings then terminated.

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(concluded from page 101)

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AUTOMATIC TRANSFER PRODUCTION

by FRANK G. WOOLLARD,

M.B.E., M.I.Mech.E., M.I.Prod.E., M.I.I.A., M.S.A.E.

Mr. Woollard has been concerned for many years with the development of flow production methods in the automobile industry. Following his apprenticeship to the Chief Mechanical Engineer of the London and South Western Railway, when he worked on the design and manufacture of steam rail cars and buses, he joined a firm of car component manufacturers as Chief Draughtsman, eventually becoming Assistant Managing Director.

In 1923, he joined the Engines Branch of Morris Motors Ltd., as Director and General Manager, and the first automatic transfer machines ever made were built during his incumbency.

In 1932, he was appointed Managing Director of Rudge-Whitworth Ltd., but left to become a Director of two Companies in the Birmid Industries Group. He retired in 1953, having given up his day-to-day occupation in 1949.

Mr. Woollard was President of the Institution of Automobile Engineers at the time of its amalgamation with the Institution of Mechanical Engineers in 1947, and became first Chairman of the Automobile Division of that body.

Since his retirement from active business Mr. Woollard has made a special study of flow production, automatic transfer machines and automation and has lectured widely on this subject.

Mr. Woollard

THE field in which automatic production can operate is very wide and covers many manufacturing activities ranging from petroleum products to printed circuits for radio sets, from spinning for the textile trades to the making of Swiss rolls and from flour milling to the production of fissionable materials.

Time, however, would not permit of such wide angle vision and this Paper is limited to a description of the process as applied to the discrete components of end products based on engineering practice. These, owing to the complexity of their shapes, the variety of operations that have to be performed upon them and the nature of the materials of which they are made have not, until recently, been regarded as suitable subjects for automatic production. This had, in fact, been limited to the types of material that, being liquid or fluid, flowed easily from process to process.

Automation, to use the new word, can be applied to many other than metal products; and furniture, clothing and boots and shoes would appear to be a few among the many goods to which these new methods could, if economically justified, be applied. The Author does not propose to enter these more speculative fields, but rather to take his examples from the automobile industry where so much has been done in this direction and where, moreover, much of his life has been spent. He was, however, invited by the President of the Institution to pay some attention to certain important aspects of the impact of these new methods in the economic and social spheres and has therefore divided the paper into three parts: (1) Machinery and Methods; (2) Economic Considerations; and (3) Human Relations and Social Consequences.

Since the beginning of the twentieth century engineers have seen some astonishing changes in the

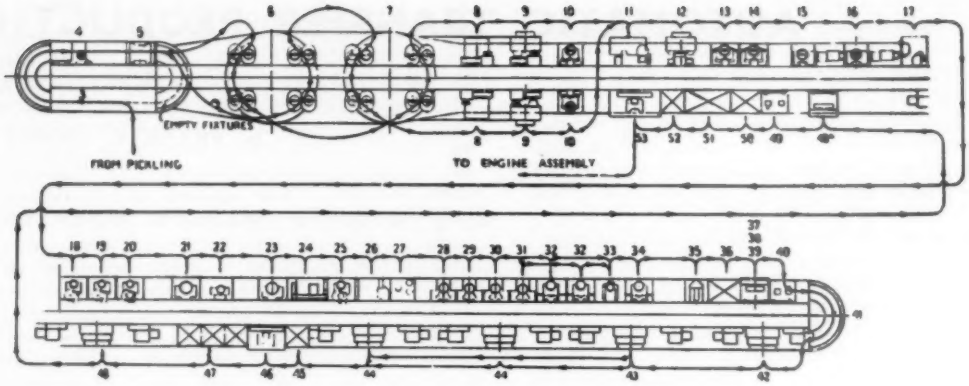

Fig. 1. Diagram of a hand transfer machine built for the Engines Branch of Morris Motors, Ltd., in 1923/4. This was the forerunner of the modern automatic transfer machine.

methods of that branch of production in which repetition is the key note. Workshops became factories based on batch production with machines grouped according to type and work was transported from department to department *via* inspection cages. With the growth of volume this system was out-moded and, with the experience gained in assembly lines, flow production, with machines arranged in sequence of operation, was adopted. Conveyors fed the machines and inspection was incorporated in the flow-line. The machines for the flow-lines were of standard types, packed up, where necessary, to provide a common table height, and joined by roller track or pendulum conveyors. This flow-line system looked like finality—like the last word in machine shop practice. To many it still looks like ultima thule and, in certain circumstances, quite rightly so.

Nevertheless in 1923, in the Morris Engines factory at Coventry, a hand transfer machine was built with the aid of a Black Country machine tool maker. This was, in effect, a wall of cast iron, 181 feet in length, which on each side carried a continuous table upon which the components (cylinder blocks) were "skidded from station to station". They were loaded into fixtures and clamped therein by hand and they were operated on by machine heads which were mounted on the wall above the table. At stations where it was not possible to slide the blocks, they were lifted into the fixtures by air hoists. The continuous table is nearly, but not quite, a correct description, since the scheme embraced two large rotating tables each served by eight milling heads for machining the top and bottom faces of the blocks.

This machine was entirely successful, it reduced the cost of machining by half and it worked out its depreciation and obsolescence rates at least twice over.

This hand transfer machine, which was an entire breakaway from current practice, was followed by two automatic transfer machines built on the same general principle but with the addition of automatic movement and clamping of the work-piece. These were not so successful; they worked well and produced accurate components, but they were so subject to the vagaries of the ancillary services, more particularly the electrical equipment, which in those days (1924—1925) was not so reliable as it is today. So, eventually, these machines were divided into single units and that was the end of automatic transfer for some twenty years, when it was resuscitated in U.S.A. being shortly afterwards adopted in France. Owing to capital restrictions Great Britain came in later and still later Germany followed. Russia has adopted the automatic transfer system and claims some spectacular successes in this direction.

Development of 'Automation'

Hard upon the advent of the transfer machine the U.S.A., led by the Ford Motor Company, introduced "automation", which term was coined originally to describe mechanism for the inter-operation transfer of components from machine to machine. This is a most important development which may greatly modify the thinking on automatic transfer machine design.

The transfer machine, coupled with automation, is bringing us within sight of the so-called automatic factory; for assembly lines are also becoming highly automatic and even inspection is beginning to yield to the automatic method.

Automatic machines are by no means new and automatic cycle machines have been known for some considerable time, but the automatic transfer machine is something quite different. It is based on the flow-line principle; and, indeed, it might well be regarded as the logical extension of the flow production system. Whereas the automatic lathe handles the small neat circular pieces and the automatic cycle machine can

perform a limited series of operations on a work piece at one setting, automatic transfer machines have no such limitations.

They can handle large, awkward, heavy and complicated pieces through as many operations as may be deemed advisable. The pieces can be loaded on to the machine at one end (either bare or on platens) and will be moved to position, precisely located, clamped, operated, released and moved again through all stages, until they emerge at the delivery end as a finished or near-finished component. The work piece can, by means of rollovers or turntables, be presented to the cutting tools on any face or at any angle. Automatic transfer machines may be ten feet or two hundred feet, or more, in length. They can be laid out in a straight line or they can double back in two or more lines if the shop layout demands such an arrangement. In brief, these machines are almost completely flexible.

Naturally there is a considerable variation in the detail design of these machines but, in general, they are made up of a foundation on which there is a table which carries the transfer, locating and clamping mechanism and a series of simple machine heads which abut or overhang the table. The transfer is achieved by a ratchet mechanism which, most frequently, consists of a spring loaded dog or pawl. This is depressed as it passes under the work piece on the outstroke and rises to carry the work piece forward on the instroke. This pawl is usually mounted on a round shaft and is known as a transfer bar. Sometimes the pawl is mounted between the links of a chain which is operated as a shuttle by two chain wheels. In another arrangement the shaft rotates through, say, 90° and has fingers which pick up the work piece on

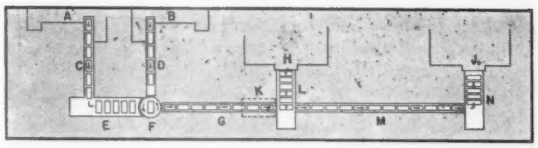

Fig. 2. Diagram of automatic handling ('automation') at Ford Motor Company, U.S.A. Cylinder blocks are taken from machines A and B by lengthwise shuttles C and D. Shuttle E takes priority over D to avoid interference at turntable F. Turntable F transfers blocks to lengthwise shuttle G. Then overhead shuttle K passes blocks to broadside shuttle L for machine H or via lengthwise shuttle M to broadside shuttle N for machine J.

the instroke, bypassing the waiting components on the out-stroke.

Sometimes the components travel bare—this is suitable for the squarish type of work piece such as cylinder blocks and heads, but frequently the work pieces are mounted on work-carriers severally known as platens, pallets or jigplates. There is an advantage in the use of the platen, since the dowel location holes can remain standard even if the design of the work piece is changed. Moreover awkwardly shaped pieces have to be mounted in a fixture and then the platen becomes a necessity. The objection to the platen lies in the fact that it has to be cleaned and returned to the starting point, and unless the return can be arranged over or under the machine this will occupy considerable floor space.

The transfer bar will carry the work piece to a fixed position where it will be accurately located by dowel

Fig. 3. A Kreuger automatic transfer machine for drilling oil holes in crankshafts.

plungers. Where the work piece goes bare, two dowel holes will be drilled and reamed before the work piece enters the transfer machine. In the platen the holes will be fitted with hardened bushes. When located the work piece or platen will be clamped to top guide rails by hydraulic or pneumatic plungers or, if a tunnel jig is used, the clamping will be to the jig. Occasionally the clamping may be operated in a downward direction or, if necessary, by side pressure and some times jigs are carried on the machine head.

Chips are carried away by a screw, shaker, slat or flight conveyor; these are frequently included in the bed of the machine. The sliding ways are kept clear of chips by gaps cut at an angle in the ways, so arranged as to scrape the chips into the conveyor.

The transfer bars can be operated mechanically, hydraulically or by compressed air, the latter being mostly in favour. The movement is usually controlled by limit switches and relays. The whole of the mechanism for the movement of the transfer bars and that of the operating heads is interlocked to prevent jamming or fouling.

The machine heads are simplified mechanisms providing a rotating and an axial motion for the drilling and boring mechanisms and a rotating and traversing motion for the milling operations. The axial motion will embody fast approach and return coupled with a slower speed for cutting and a dwell where necessary. Tapping will be controlled by lead screws. Deep hole drilling will have a reciprocating motion for clearing and cooling the drill. Milling as a rule will be limited to a single traverse. The machine head motions will be controlled by limit switches. Two motors are frequently employed on the heads; one provides the power for the cutting head, while the other operates the approach and return movements. In some instances provision is made for changing the gearing in the head *in situ*, but in others the heads are reduced to the simplest possible form and, if a change of gearing is required, the head is unshipped and sent to the maintenance department for the change.

Automation started life as inter-operation transfer, but the term has been widened to include all the automatic process methods. A recent definition reads: "Automation is the automatic handling *and machining* of work-pieces in progressive production processes". In U.S.A. the term automation has been stretched to cover the removal of chips and surplus material, the baling of the same and the circulation of coolants.

The normal method of operation between machines is carried out by the use of three types of shuttles known as lengthwise, broadside and overhead shuttles. These are carried on steel framework and consist pneumatic or hydraulic cylinders to which bars, similar to those used in transfer machines, are attached. The lengthwise shuttle is virtually the same in arrangement as in the machines while the broadside, usually with a different type of catch or pawl, consists of two transfer bars spaced so that a wide workpiece is unable to skid sideways and cause a jam. The overhead shuttle has a trigger arrangement to

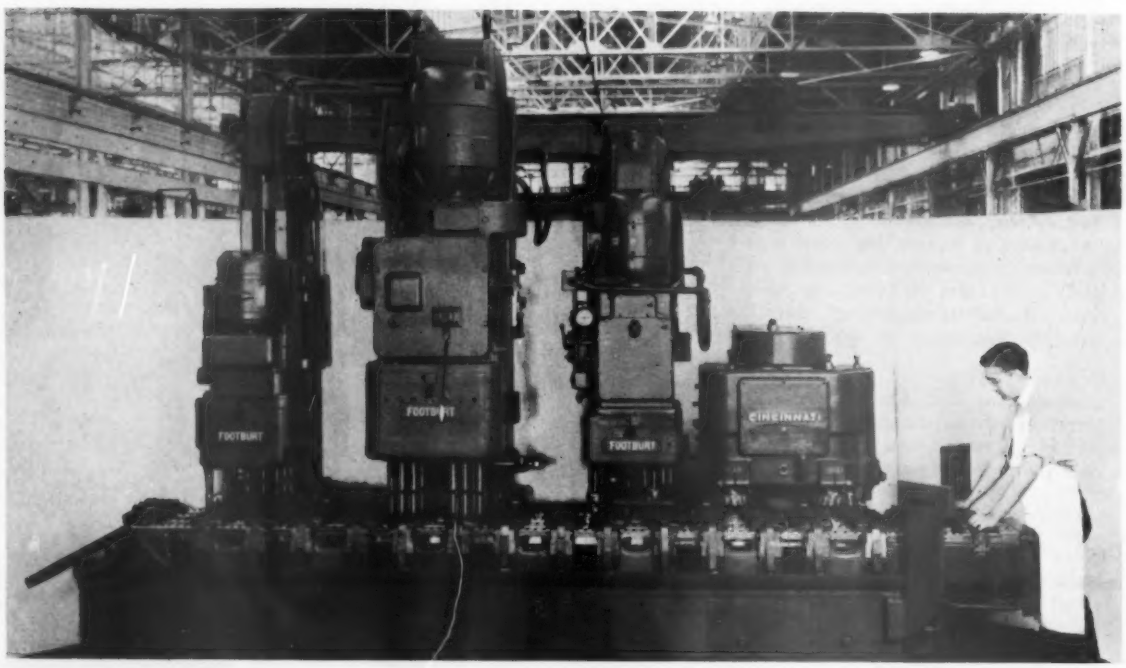

Fig. 4. Footburt-Cincinnati automatic transfer machine for milling the water outlet face and drilling and spot-facing stud holes on the Ford cylinder head.

pick up the work pieces, this trigger being mounted on guide bars. The overhead shuttle is essential where lengthwise and broadside shuttles intersect because these cannot cross each other, hence the overhead shuttle picks up from the lengthwise shuttle and transfers to or through the broadside shuttle and *vice versa*. These shuttles are, for the most part, operated by compressed air and they are controlled in their movements by limit switches. They can be used to distribute the workpieces to the machines in accordance with the needs of the situation. For example, Operation (A) may need only one machine to cope with 100 pieces per hour, but Operation (B) may be done on machines whose capacity is limited to 50 pieces per hour. By the use of limit switches the pieces from (A) can be offered to (B_1) until the track is filled, when the pieces will, automatically, be switched to (B_2).

In the inter-operation transfer line there can be be simple turntables and rollovers or combined turnovers and rollovers, so that the work piece can be presented to the tools on any face or, indeed, at any angle. For example, a cylinder block may be milled on the sump-face and rolled over for machining on the head face after which it may be half rolled, and turned through 90° to go down another line, for the machining of the port face. In this way all manhandling of these heavy parts is eliminated.

Link Up with Standard Machines

Automation can link up standard machines as well as the transfer types, and this has modified American thinking on machine tool design, for when individual tools were fitted with transfer equipment to pick up the pieces presented by inter-operation shuttles, a new situation was created. By this means, the heavier plant such as large milling and boring machines can be brought into the field of automatic operation; moreover, not only the specialist machine builder but the whole of the machine tool industry can participate in supplying tools for this new system.

This does not mean that automatic transfer machines will be relegated to the background, but rather that their role is to deal with the subsidiary operations such as drilling, tapping, reaming, countersinking, spot facing and the light milling operations—the heavy milling, boring and broaching being done on single purpose tools fed by automation. These methods are in use at the new plant of the Ford Motor Company in Cleveland, where rough cylinder block castings are fed through a series of machines linked by automation whence they emerge ready for assembly, having occupied only one-fourth of the man power previously used for this purpose in this very efficient organisation.

To return to the transfer machine : it will be appreciated that everything must be done to keep the machines at work. Hence tool changing must be organised. This can be done by working to a strict schedule wherein all tools are changed at stated intervals of time. Even this function has been partly mechanised by means of the " Toolometer ", a special type of tool crib allotted to each transfer machine.

Fig. 5. Close-up of the spot-facing operation on the Footburt-Cincinnati transfer machine.

The "Toolometer" consists of a bench combined with a special type of tool rack and a series of indicators which give warning when tools need to be changed. The bench carries fixtures and gauges for tool setting and the tool rack has " cartridges ", so called, for holding the tools. Labels alongside the " cartridges " identify the positions on the machine. These are often coloured and the machine heads are matched to these colours for quick identification. The " cartridges " are in duplicate to provide tools for accidents or breakdowns. The indicators are operated on the machine cycle and the " clock hands " move one space for each cycle. On the dials are marked the danger zones, with limits, and when the hands reach these zones is time to change tools. Warning lights or sound signals are also in use.

It has been recognised that with the high output from transfer machines it is not essential for these to operate at the maximum cutting feeds and speeds. Lower speeds giving a longer tool life are often found to be a much more economical proposition.

Holes that are to be tapped are gauged for depth and to see that there is no obstruction from imprisoned chips. This is achieved by having depth gauge plungers which also act as blow-out jets, the air coming through the hollow plungers. This is an indication as to how automatic inspection could be achieved.

Inspection is carried out at the end of the line ; there being so few units in operation to be scrapped makes this a feasible and economical method. If an intermediate inspection is deemed necessary, during the operation, it can be carried out at an idle station. It is advisable to have one or two idle stations on any machine where an additional operation may have to be added.

Among the more important of the automation developments are those of loading and unloading presses. These devices speed up the machines very considerably and they reduce the number of accidents to which this operation is particularly liable. The " iron hand " made by the Sahlin Engineering Co., of Birmingham, Michigan, U.S.A., is interesting, since it will unload panels up to 80 × 120 inches, weighing 100 lb. or even more at 12 to 15 per minute. A smaller edition dealing with pressings up to 20 lb. in

Fig. 6. A 13-station automatic transfer machine for operations on the Austin A30 gearbox. The drill guide bush plates on this machine are retractable.

weight unloads at the rate of 20 per minute. After unloading the press, it places the piece on a conveyor, face up or down, as required for next operation. The sequence of operations is : (a) ejectors in the bottom die lift the component about one inch ; (b) the " Iron Hand " grasps the part ; (c) a pneumatic cylinder gives it sufficient vertical lift to clear the die ; (d) another cylinder swings the component out of the press ; (e) the hand releases the pressing which falls on face or back according to the point of the swing-back at which it is released.

Press loading has also arrived ; some of these devices are simple but many are quite complicated mechanisms. A particularly interesting example, remarkable for the simplicity of its design, has recently been made for a large Midlands Engineering Group. It feeds a press with drawn shells for reforming. The shell is delivered on to a conveyor platform and elevated to operation height, when it is seized by a pair of tongs and pushed into position on the press tools. After re-forming, the pressings are ejected into a chute to gravitate to the next operation.

Those using these press loading and unloading devices agree that they speed up the presses by upwards of 30%, and that the reduced absenteeism due to injury makes for even greater economy.

The automatic method is not limited to machine operations ; it can apply to assembly and has much to recommend it in that application. In assembly the performing of operations automatically, although this is one of the aims, is perhaps not so important as the bringing together of the components in the exact position where they are required at the precise moment in time when they are needed.

The most advanced example is that of the car assembly at the Austin Motor Company. There are three tracks in operation, one being for the chassisless A.30 model. Possibly the A.40 and A.70 operations are the more interesting. These tracks are in four sections although, in effect, they are continuous. They start as slat conveyors running through a marshalling area wherein all the smaller components and minor assemblies are held in a two-day store. The tracks are loaded at each station with sufficient parts, to complete a car, laid out in pre-determined order. As the laden tracks emerge from the marshalling area, they receive the frames delivered from a frame store (outside the assembly hall proper) by a Telpher conveyor. The frames are located on the track in such positions that all subsequent assemblies will be matched to the frame without the necessity of manipulation. Rear springs are attached at the next station and then rear axle and the front suspension are delivered by an elevator which draws these assemblies from conveyors running in a tunnel some 20 feet below floor level. At succeeding stations other components are attached, then the engine and gearbox assembly is delivered by another elevator from the stock carried under ground. The clutch control added and the steering mechanism coupled up, the slat conveyor doubles back to the marshalling area.

The chassis is transferred to an overhead conveyor for transport through electro-static painting and hot chamber drying booths, after which it is again transferred to another slat conveyor proceeding to an oil filling station where engine, gearbox, rear axle, steering box and brake cylinder receive their quota of oil. The exhaust system which bypassed the spray painting booth is now fitted, by which time the chassis has arrived at the elevator which deposits the body on the chassis frame. Road wheels are fitted to the hubs and a multi-head nut runner tightens all nuts at one operation.

The car now enters on to the fourth conveyor which has an elevated double track enabling fitters to reach all parts around and underneath the car. Further coupling up takes place, the bumpers are fitted, electric wiring is completed and work stains removed, tyres are inflated to correct pressures, water and petrol is put in and the car driven off for inspection and despatch. The remarkable part of these assembly lines is the control system, which not only ensures that the sub-assemblies arrive at the right place at the right moment, but which also sorts out the different units to a pre-determined schedule. This is more appreciated when it is realised that there are four different types of body, right and left hand steering, optional heating and radio and also colour variations.

To deal with the situation a production schedule is planned and a master list compiled which shows the sequence in which the models are to be delivered to the despatch department. From this master list packs of punched cards are produced on Hollerith equipment, and by means of sorting machines these cards are passed through an electric field where contact is made in accordance with the card punching. This sets the units in motion on the conveyors in the required order. The units are moved by dogs on the conveyor which ride over the carriers of the units until solenoid operation lowers the chain to effect engagement.

The assemblies, loaded in the correct sequence by these means, are held in storage areas until required, when they are again sorted and despatched through the previously mentioned 1,000 foot tunnel to halls under the assembly lines, whence they are transferred to sidings of the assembly line to which they are allotted and from which the elevators pick them up on an electric signal from the track—this being given by the engagement of limit switches.

The accuracy of the delivery of the units is noteworthy ; the power unit, for example, requires practically no manipulation by the fitter who bolts it to the chassis, it will arrive within " half a hole ". The same applies to the fixing of the body. The elevator slings are self-detaching and, having delivered the unit, the elevator retires to pick up the next unit and to await the next signal from the track.

This highly automatic assembly line will, undoubtedly, encourage others to attempt the same methods on smaller products and it may be remarked that it is sound policy to commence automation on the assembly line.

Economic Considerations

The foregoing is a broad outline of the new methods of automatic production which is, of necessity, brief since the Author has been asked to touch on all aspects of these new developments, including those relating to economics and human relations. Those who wish to study the mechanics in greater detail will find references in this issue of the Journal to all recent articles published on this extremely interesting subject. Dealing with economics—the first obvious question is : what advantages are gained by the adoption of these new methods ? The answer is that the primary reason lies in the extremely high percentage of machine utilisation due, of course, to the unbroken continuity of processing.

For the better part of 100 years we have been improving the cutting efficiency of our edged tools and some of the recent improvements are amazing. Based on high speed steel in, say, 1928, the carbide tools of today are showing advances in rough milling of 450%, in rough turning of 500% and in rough facing of 875%. Until recently the method of handling work in and out of machines has seen

Fig. 7. A 19-station automatic transfer machine operating on the Austin A30 cylinder head.

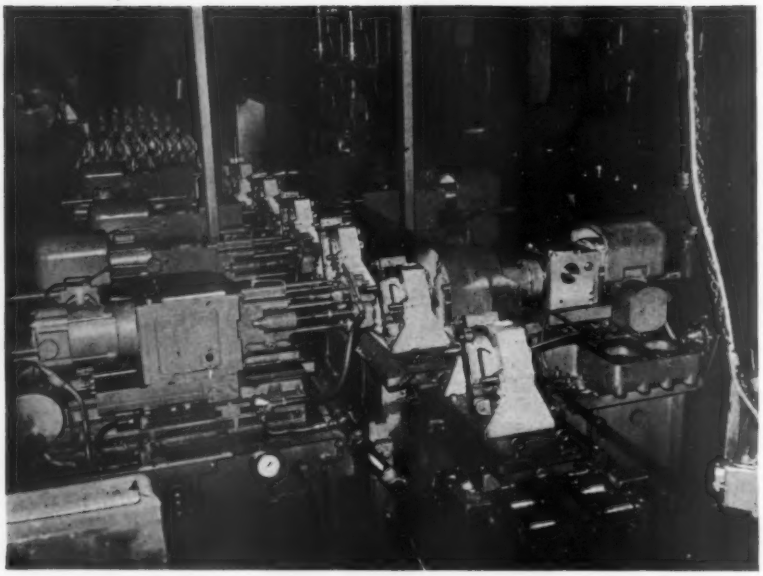

Fig. 8. A 7-station transfer machine operating on the aluminium rear axle gear carrier. A fixture is mounted on the platen. The transfer bar can be seen in the foreground.

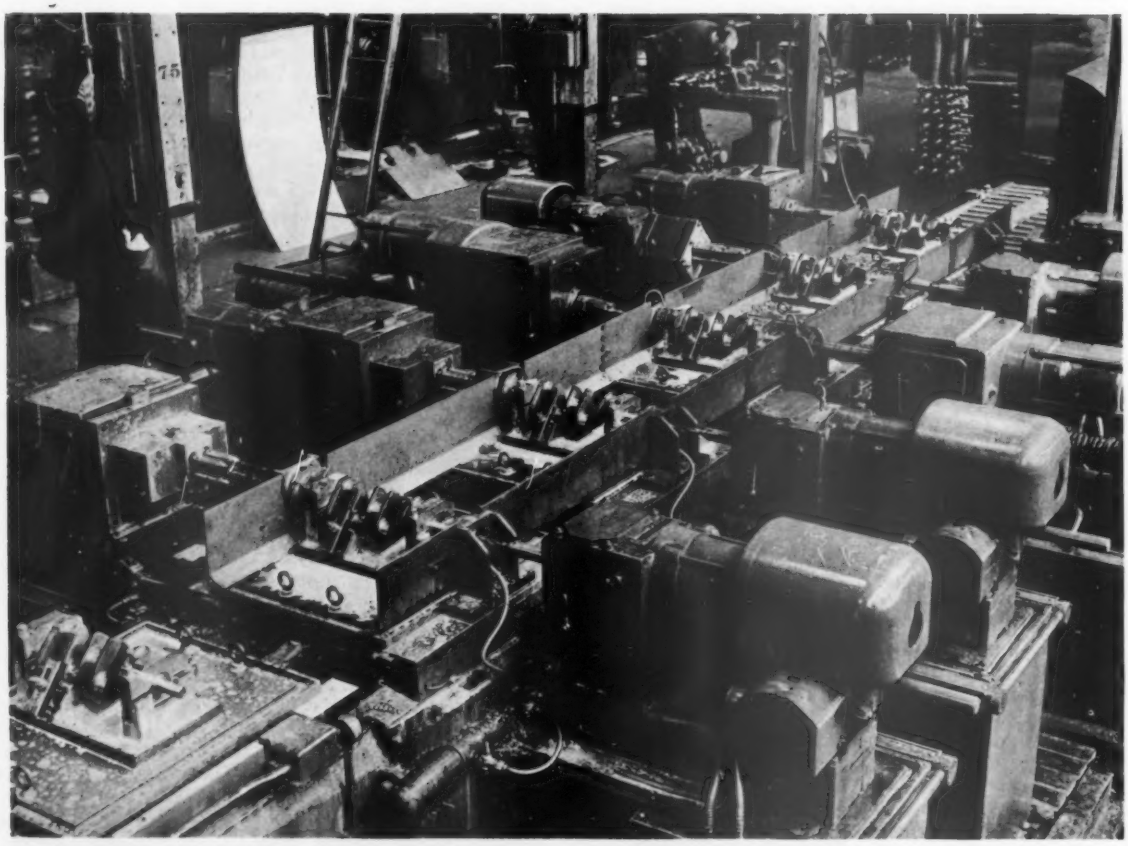

Fig. 9. A 7-station transfer machine for drilling, tapping and forming both ends of the A30 crankshaft. This is located in the fixture from journals and pads which have been turned and milled at an earlier operation.

nothing to compare with this. But with automation the manpower operating the machines is frequently reduced in the proportion of 6.5 to 1 and commonly by 4.0 to 1. The cutting tools, owing to the greater overall efficiency of the machines, need not be forced so that tool life is greatly increased and down time considerably decreased. In flow production the inventory can be reduced by large amounts and with automation this process can be carried much further. Stock control becomes easier and the balance of parts for the assembly line is more readily maintained. Manhandling is obviously reduced to a minimum on the shop floor but this is not a net gain, since more technicians are needed. The discipline exercised by the needs of these machines in regard to servicing, tool changing, etc., is highly beneficial. This must be organised and the stoppage of a large unit of production is much more highly visible than the stoppage of a number of small machines.

The production engineer will wish to know in what circumstances the employment of transfer production can be considered. In the Author's opinion this is purely a matter of economics based on ascertainable fact. It is obvious that this is a mass production process and that flow production (which is mass production with a difference) should preferably anticipate transfer production. If a firm producing a line which is in continuous demand, has installed flow production methods and is reasonably satisfied that the demand for the product will continue without major alteration, they will have created a situation which is ripe for transfer production. In such a case the savings in operation can be estimated and balanced against the cost of the new plant. Thus the decision can be taken with full knowledge of the economic position. Incidentally, it is not necessary to delay the decision until all the processes are ready for automation, for transfer production can be applied sectionally, to one component at a time, and that possibly is the best scheme on which to plan.

Mechanisation for its Own Sake

Since there is no doubt about the fascination exercised by these new methods it is necessary to guard against the possibility of falling in love with mechanisation for its own sake. The decision to adopt transfer production must be taken on economic grounds only (possibly, in this country, this warning is superfluous). If, however, the circumstances are favourable the adoption of transfer methods will, undoubtedly, be of great advantage to the concern. In passing it may be pointed out that where the task is unduly distasteful, where there is a distinct element of danger or where there is difficulty in obtaining labour, the strictly economic view may well be modified by such circumstances.

The industries that are most likely to benefit from automation are the mass production industries in which motor cars, bicycles, office machinery, electrical equipment and domestic appliances predominate, but in which it is conceivable that food products, furniture, boots and shoes, leather goods and other non-metallic quantity produced articles might participate. Each new invention widens the sphere for automatic production as witnessed by the gramophone, radio, television and voice recording instruments, to name one group of associated products, or cameras, enlargers, cine-cameras and projectors to name another.

There is, of course, a limit beyond which mass production cannot go; the limit is reached when the consumer wants the personal touch, in other words, when the utilitarian motive for buying has been passed. Such articles as fashion goods are out of the range and scope of mass production processes but they are useful in indicating the trend of style. Thus they assist the industrial designer to improve the appearance of mass produced articles ; so helping to sustain longer runs on the machines. This is well

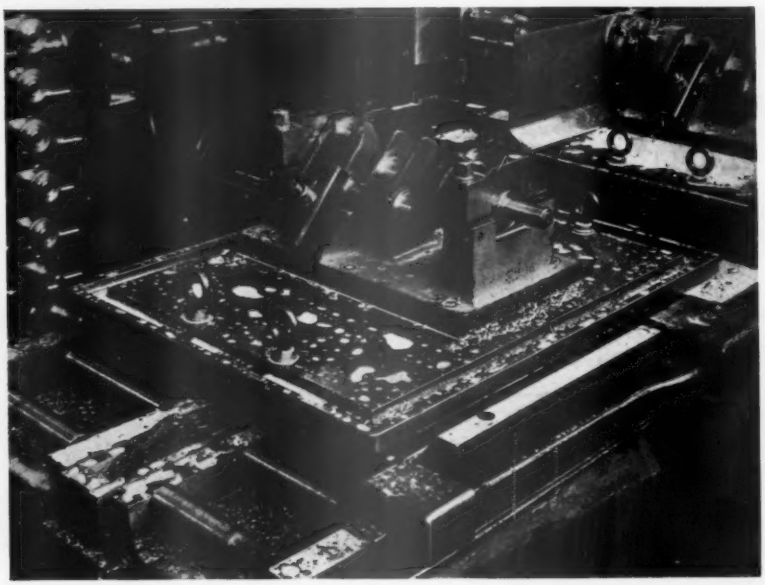

Fig. 10. A loading station for the operation shown on the crankshaft transfer machine. The eyebolts on the platen are for slinging the platen on the return conveyor.

Fig. 11. A crankshaft milling fixture. The crankshaft is automatically lowered into this fixture from the line conveyor. Then clamping rams come into operation against self-locking wedges which prevent displacement if the air supply should be cut off. The final clamp movement sets the machine in motion. The hand controls shown are for test purposes only.

exemplified in the manner in which high priced motor cars, and also the sports editions of the popular models, influence the designs of the standard ranges. Forward-looking design is essential for end product manufacturers who are employing transfer equipment. Even in such utilitarian goods as washing machines, lawn mowers and vacuum cleaners sales are greatly influenced by good appearance and ultimately it is on continuous sales that the full utilisation of transfer machines depend.

Automatic transfer machines are, at the moment, more expensive than a line of production machines but less expensive than universal machines, which have disappeared from flow line production, but it must be remembered that they embody the transfer, locating and clamping mechanisms. In the long run they should be more economic to buy because the simplified heads should be easy to maintain and the obsolescence factor should be considerably less.

It may be objected that these are specialised machines and that if the product for which they were designed changes the machine is useless or, at best, is only rebuilt at enormous expense. This, however, need not be so. If the heads are standardised, and that is happening in most examples, they can be salvaged entirely and put to other uses—i.e. coupled in another sequence—and there is no reason why the beds cannot also be built as standard units as in the Renault machines. The platens can be used again and the fixtures and jigs would, in any case, have to be changed for the new component. The beds should be made to a standard module and it may be that more than one module might, depending on the nature of the components, have to be adopted. In one concern the bed sections are built for two and for three heads so that any combination of lengthwise spacings can be made. (Thus : two or three or $2+2=4$, $2+3=5$, $3+3=6$, etc.).

To take care of minor changes, idle stations can be introduced among the working stations on which supplementary heads can be mounted if need arises. These idle stations can also be used for intermediate inspection should that be necessary. In most instances the component affected will only be changed in detail and not in overall dimensions, so that the same platens and the same spacing on the table will serve. The heads are usually made to take single spindles, multiple spindles and right and left hand milling attachments. Changes in multiple drill heads can be accommodated by fitting a new cluster box in the same manner as would be done in a normal flow production set-up.

Obviously it is not as simple to make a major change on a transfer machine as it is in a flow line of normal type, because of the transfer mechanism which does not exist in the flow line, except in a rudimentary

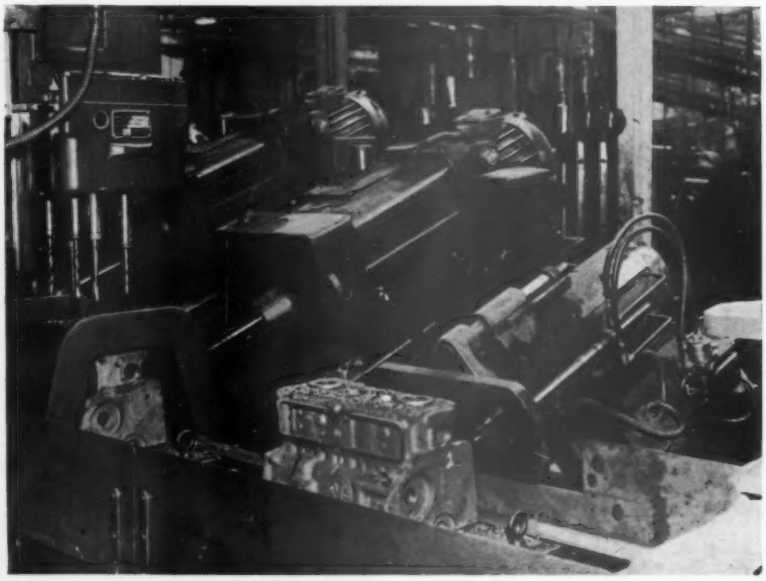

Fig. 12. A blow-out and gauging unit. These units are necessary to ensure that, before tapping, blind holes are freed from chips and are of the correct depth. The depth gauge, being hollow, provides a duct for the compressed air—see right of illustration.

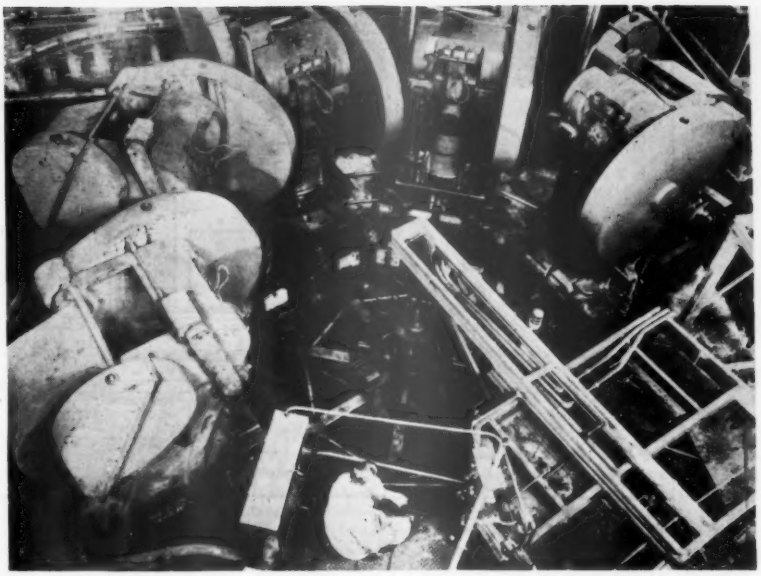

Fig. 13. This circle of punch-presses in the Ford Motor Company's plant is a good example of automation. The five machines are fed in sequence by a merry-go-round that holds the workpiece throughout the whole operation. Split axle-housing tubes are loaded into the spider arms at a station which can be seen at the lower right of the picture. Banjo-face contours are formed in each piece successively, the work being automatically ejected to move on to the next series of operations. One man operates the whole apparatus which replaces a normal press line with a man to each press. The elimination of hazards is an important feature.

sense as a belt or pendulum conveyor which has no positioning, locating or clamping mechanism. Nevertheless, the changes in fixtures, jigs and tools which are common to both transfer and flow-line would probably be the bigger task when a change of model is contemplated.

Changes of model do not affect inter-operation transfer equipment nearly as much as they do the in-line multi-station transfer machine because, while it is keyed to the time cycle it is free of the ancillary mechanisms of positioning, locating and clamping. Where automation of this kind serves individual machines with their own transfer and clamping mechanisms, the matter is quite simple and one might be tempted to think that it would be better to avoid transfer machines and to build on an inter-operation transfer system only. That is arguable but it is doubtful whether, on examination, it would be feasible or satisfactory on any but the larger machines that perform the major operations.

Summing up the economic argument it can be said that automatic transfer machines will promote very considerable savings in labour and in tool cost and they will reduce the inventory carried. They can be contemplated in those plants that have a continuous demand for a standardised product which is likely to remain in demand for a reasonably long period without calling for major modifications. It is desirable, but not essential, that those contemplating transfer production should have graduated through flow production. It may be an advantage if transfer machines are introduced gradually and the number increased as experience is gained, but there is nothing to prevent the installation of batteries of machines if, after careful consideration of the economic factors, the situation warrants this action. The first cost of transfer machines comes high but the depreciation and obsolescence factors should be lower than that of standard machines because : (a) the units are basically simple and repairs and renewals are relatively inexpensive and (b) because the machines, while special, can be rebuilt for other purposes if, and when, this becomes necessary.

Human Relations and Social Consequences

This Paper is concerned with only one aspect of automatic production, that being mass production based on engineering practice, but automation covers a much wider sphere, which is extending. It has become extremely important in the manufacture of chemical, petroleum products, fissionable materials and the production of rolled and extruded metals and it is being applied in other directions. The Author must limit his remarks to the industries with which he is familiar, but it is probable that a similar pattern of social effects runs through all these activities. Automation will affect management, supervision, operatives and consumers: let us first consider the consumer.

For the consumer automation means less expensive goods (maybe in these difficult times this should be qualified by the word "relatively"; it may, of course, result in holding prices down rather than reducing them). Automation also means that an extended range of products will be brought within the consumer's purchasing power. Let us digress a little to say that people who would never have been "carriage folk" have been able to acquire motor cars because automobiles are all-in-all cheaper than carriages. This has been made possible by the mass production techniques coupled with the larger earnings that arise therefrom. Automatic production will enhance this tendency, bringing more goods in the "luxury" or non-necessity classification into the homes of those who otherwise would be unable to afford them. In this way, automation will make a very positive contribution to the standard of living.

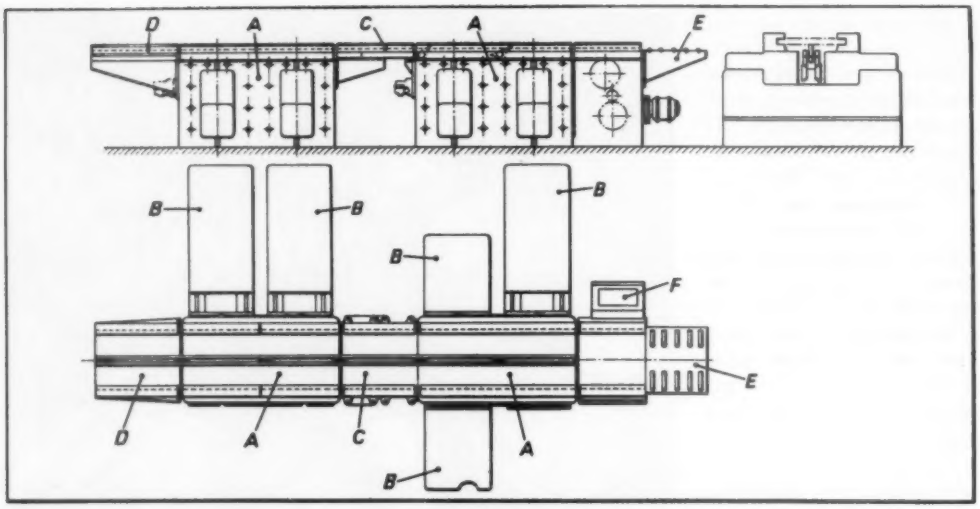

Fig. 14. Base units of the Renault transfer machine. (A) base unit. (B) machine head platform. (C) bridge piece. (D) loading section. (E) unloading section. (F) indexing mechanism.

There is another side to the picture, inasmuch as automation will bring in its train further specialisation, standardisation and simplification of product, but that need not mean stultification of design. There are so many things that can be standardised without affecting our natural desire for differentiation that, providing the purveyor of goods that need a distinctive and personal touch observes his obligations to society, we can live in a world of automation and individuality. In automobiles and home appliances, to take two of the major fields for automation, it is surprising how much standardisation could be adopted without our being even aware of it. Moreover, since the luxuries of today are the necessities of tomorrow, we can be sure that as the needs of the community are filled the fashion and style demands will increase and the law of the situation will, in a free society, ensure that these demands are satisfied.

The Effects on Management

In addition to deciding when to adopt automation and to what extent, management will have the task of building up an organisation which will have to deal with an entirely new set of conditions. It is essential that continuity of operation should be promoted and this means that diversity of product must give way to specialisation, standardisation and simplification. There may be a need for considerable re-thinking as regards product design both in respect of machining and of assembly, for automatic or near-automatic assembly will be a feature of the highly automatised factory of the future. This will also include finishing, plating and painting operations.

Some entirely new conditions will have to be faced; for example, calculating overheads on labour cost will be exposed for the fallacy that it has always been. When one man with the aid of automation does the work of ten or a dozen, the on cost will hit the ceiling. Likewise, incentives for labour will have to be revised since the machine will set an unalterable pace; so piecework and similar systems will fall into desuetude. The most likely incentive would seem to be a premium on machine utilisation. Similarly, time and motion study will become out-dated by the work study that will be embodied in the machines. Changes in inspection methods will be necessary and much automatic inspection will be introduced. Planning will become all-important for it is in the planning office that, logically, these methods should originate. Product spares and service may pose certain difficult problems which should be the subject of policy making by management before the new methods are adopted; labour relations will have to receive careful study particularly in respect of technological displacement. Labour must be encouraged to co-operate in the new methods. Finally it must be remembered that, as in flow production, automation is a marriage of management and mechanics with management as the dominant partner.

The Effects on Supervision

It has been the experience in American factories that, with automation, more and not less supervision will be required. The tempo of all operations is faster. Down time of machines is a more serious matter and co-ordination throughout the whole plant is more important. More concentration on the quality aspect of the product is necessary. Thus although the super-

visory staff are relieved of many worries in regard to men, they will need much greater concentration on the machines. There will be far fewer operatives but many more engineers, electricians and maintenance men serving under them or with whom they will be in close contact. These men will, on the whole, have high technical qualifications and for the most part will have been specially trained for their duties.

Chargehands will grow in stature and will become rather more like ship's engineers or shift engineers at an electricity station, more in charge of plant than of men, although men will still be the major factor. Communications will need to be more rapid, and certainly more explicit, all down the executive line. Both radio and television are being considered in U.S.A. for this purpose. Radio sets for instructions to track drivers* are already in use and walkie-talkies are envisaged for other purposes.

The Effect on Workpeople

The effect of automation on workpeople has been left, because of its importance, as our last consideration. The workers are liable to be affected in a particularly personal fashion and they, therefore, must be given special attention. Automation will, of course, be responsible for a certain amount of what is euphemistically known as technological displacement; that is evident from what has already been said. While this does not, necessarily, mean unemployment in the broad sense, it must mean re-deployment and this is a matter in which industry is, or should be, particularly concerned.

We have ample evidence that new inventions and methods mean more and not less employment coupled with a higher standard of living. Our own country bears witness to this since in 100 years our working hours have been reduced by 30% and real wages have increased during that period by about 250% while U.S.A., which has the greatest amount of mechanisation, also has the highest standard of living in the world. But the displaced person will have no quarrel with these statements. He will not dispute the

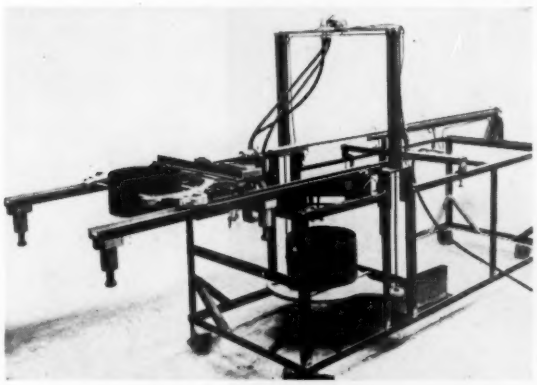

Fig. 16. This press feeder accepts drawn shells conveyed from a previous operation, elevates them to operation height, and places them in position for a further press operation.

*As this was being written there was an announcement on the radio to the effect that a large Black Country firm were doing likewise.

Fig. 15. A simple unloading device is seen in these retractable work stops located within the press. Each dash panel loaded into the press is stopped by the extended arms. After the press down stroke the stops retract and allow the panel to slide down the ramp on to a belt conveyor which carries the workpiece to the next operation. After the panel passes, the stops extend again to catch the next part being stamped.

long term issue. It is *his job here and now* with which he is concerned. He also, in his heart, knows that we "cannot put the clock back" and that if we do not pursue the pattern of development prescribed by circumstances some other nation will do so to our detriment. Yet this problem is immediate, intimate and personal and management should endeavour to help in its solution.

The result of automation will be that production will be greatly enhanced, that fewer men will be required on the machines but more on supervision, machine adjusting, tool setting and maintenance. Some of the dispossessed can be upgraded and here

Fig. 17. Wheel transfer device. Wheels on the paint shop conveyor are unloaded on the " hand " of this device by " push-off " rams operated by limit switches. The " hand " immediately drops to clear the hangers and this initiates a rotary movement which carries the wheel to a distributor conveyor whose hanger fingers interlace with the " hand " to pick up the wheel.

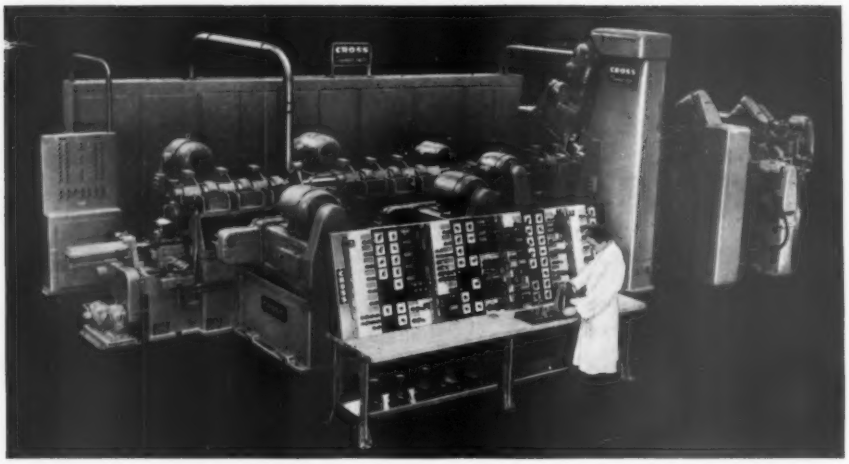

Fig. 18. A Cross " transfermatic " machine with its " Toolometer "—a special tool crib.

management can assist by training those suitable for their new duties. Expansion of the business by reason of the cheaper product may help with others. Also employers, by co-operation with the Employment Exchanges, can help materially to deal with any remainder. This task is not so formidable in practice as it appears in contemplation, for the new machines are not available "off the shelf" and their building, installation and tuning up takes a considerable period of time. The company installing them is unlikely to make a quick and sudden change from one system to another and with a sympathetic eye on the situation much can be done. Moreover, the building and equipping of the new plant will absorb large numbers of men and this, again, will tend to ease the situation. The gains to the work people will be those of lighter tasks, more interesting jobs and good chances of an up-grading of status.

As consumers the workers will share in the goods produced and when, in due time, automation becomes more general, they may even gain greater leisure. One last word on this subject; we must keep our sense of proportion in this matter. Automation is a continuous process method which applies to those end products which have a continuous and predictable demand, and this means the mass production or near mass production industries. There is, of course, a vast amount of work which does not fall in this category and this will not be disturbed by these new methods.

In the Author's opinion, for what that may be worth, the social effects of automation will be beneficial; providing they are applied to peaceful ends.

Fig. 19. Close-up of a " Toolometer " showing gauges, setting fixture, cartridges and cycle indicators.

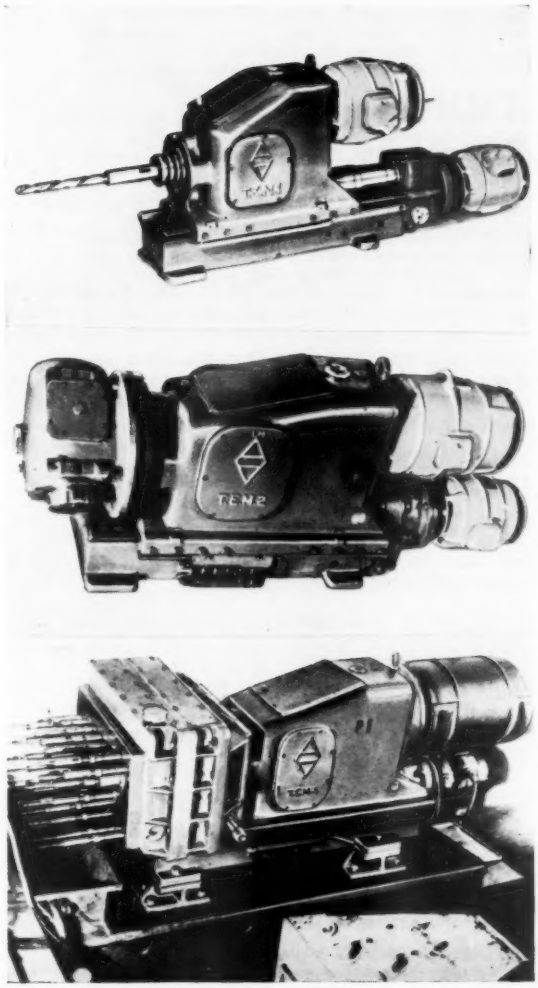

Fig. 20. Single-spindle and multi-spindle drill heads made as package units. The centre photograph shows an attachment for milling. These heads are quite self-contained.

Automation will considerably decrease the costs of production of those products to which it is applied and it will be particularly effective in regard to the domestic utilities. Thus it will be of very great service to the housewife and will help her to escape some of the drudgery that her valuable contribution to society involves. It will help to increase the new luxuries and near-luxuries and to bring them within the reach of many more people. It will bring into wider use, better lighting, space heating and those hot water supplies on which the labour-economy of the household is founded: the appliances will be more easily available and much cheaper. It will also help to provide those factory requirements which lend themselves to mass production; not the least being the electrical, mechanical, pneumatic and hydraulic devices used in automation itself.

At the factory it will have the effect of eliminating drudgery for the worker and it will tend greatly to improve worker status by providing more and more highly technical tasks in supervision and maintenance. It may, in due course, lead to higher remuneration or more leisure, or both; that has been the result of mechanical progress since the industrial revolution and there is no reason why it should not continue.

Management, including supervision, will benefit by having more highly integrated factories which should be competitive with low cost labour in less developed countries which otherwise might adversely affect our markets. The work produced will, undoubtedly, be of equal or better quality than heretofore Like flow production from which it is a lineal and legitimate descendant, automation — in addition to being a tool of production—is a tool of management and the validity of its being—the justification for its existence —will rest on the integrity and the capacity of management.

Acknowledgements

The Author wishes to thank the following for their courtesy in permitting reproduction of certain illustrations in this Paper :-

Figs. 3, 4, and 5—The Ford Motor Company and The Machine Tool Companies;

Figs. 6, 7, 8, 9, 10 and 12—" The Automobile Engineer " and The Austin Motor Company, Ltd.

Figs. 11, 16, and 17—The Hymatic Engineering Company, Ltd.

Figs. 2, 13, 15 and 18—" The Machinist ".

Figs. 14, 19, and 23—" Machinery ".

A bibliography on automatic transfer machines, prepared by Mr. F. G. Woollard, appears overleaf. Additions to this bibliography will appear in a subsequent issue of the Journal.

AUTOMATION
A Select Bibliography

THE word "automation" was coined by Del. S. Harder, Vice-President of Manufacturing at the Ford Motor Company—U.S.A. in 1940. It was at first used to describe the automatic transfer of workpieces from machine to machine, but it is now being applied in a more general sense to automatic operation. This word has a respectable, if mixed, parentage. It is derived from the Greek automatos, self-moving: A U T O S, self and a stem M A T –, moving. To this is added the Latin suffix I O N, being or state of being.

Thus the term automation is descriptive, it is easy to pronounce, and sufficiently different from similar words to make readers aware that it relates to something new.

The alternative would have been "automatisation" which is ugly and rather a mouthful. After careful consideration automation can be offered to British engineers as a satisfactory description of a method of operation which will revolutionise the mass and flow production industries.

In U.S.A. they also use a verbal form, to "automate", to describe full or partial conversion of a plant to automatic operation and they refer, in the past tense, to plant that has been automated. It may be that we, in Britain, would prefer the verb "automatise" with its past tense "automatised" but then, to be consistent, we ought to refer to "automatisation" instead of automation.

One hears a murmur: "Does it matter?" Well—yes, it does, for automation is going to revolutionise our methods of quantity production and we may as well start by giving it a distinctive, descriptive, and easily recognised appellation.

This is a supplement to the bibliography on Automatic Transfer Machines, which was published in this Journal in September, 1953, pp. 414-415. A few reprints of this original list are still available from the Hazleton Memorial Library.

For the selection of articles for inclusion, and for the annotations, the Institution is indebted to Mr. F. G. Woollard, M.B.E., M.I.Mech.E., M.I.Prod.E., M.S.A.E.

The numbers after the titles of the periodicals refer to the volume, pages and dates of issue.

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97: 121–184, October 12th, 1953. Ford bet a billion on new tooling. **"An important piece of documentation telling of the greatest modernisation programme in the whole of industrial history It contains many photographs comparing old and new methods in the Ford factory. Covers also automatic transfer machines that have been installed and other automation methods. Of prime importance to students of ultra-modern machining nethods."** Abridged in: *Machinist* 98: 109 124, January 16th, 1954.

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7: 53–54, July, 1954. What's so new about automation? **"A provocative article.,'**

7: 55–57, July, 1954. Control circuits for fluid powered work transfers. **"Gives useful details of pneumatic, hydraulic and electrical automatic operation."**

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7: 62–63, July, 1954. Air operated turn over.

7: 64–68, July, 1954. Hydraulic drives for continuous process industries.

AUTOMOBILE ENGINEER

43: 359–362, September, 1953. Mechanized manufacture: important American production developments. **"A summary of the situation in regard to automatic inter-operation movement of components, including assembly."**

44: 323–325, August, 1954. Perry, H. W. Automation: recent developments at Ford Motor Company, U.S.A. **"A short but extremely useful article describing the Cleveland plant of Ford Motor Co. This is probably the most highly automated plant in the world."**

AUTOMOTIVE INDUSTRIES 109: 38–40, August, 15th 1953.

Geschelin, J. Scrap disposal by automation: Fisher Body Plant.

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Transfer machine for production of automobile components.

HAWKINSON, D. E.

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IRON AGE

171: 232–235, May 7th, 1953. Automatic handling in smaller pieces pays off in stamping. **"Automatic operations in Fisher Body Div. of General Motors Corp. Interesting to producers of welded pressings."**

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172: 157–159, September 17th, 1953. White, S. J. Automatic feeding devices produce small parts faster. **"Automatic hopper and magazine feeds for centreless grinding, and other operations in the manufacture of cast iron valve guide bushings for Buick V-8 engines."**

172: 99–101, November 26th, 1953. Automatic units speed aircraft engines asembly: Describes how automatic assistance in assembly reduced costs by 50%; also how 2.5 times the amount of work is done in 42% less space than the original set up.

172: 47, December 24th, 1953. "Automation—more than a pushbutton." Indicates that management of automatic plant involves new problems, social and psychological; also stresses the necessity for training technicians more intensively.

173: 314–316, January 7th, 1953. Production processes . . . automation. **"Describes outstanding developments in automation in 1953, and indicates trends for the future."**

174: 114–116, July 1st, 1954. Patton, W. G. Design tooling for complete automation. **"Title is misleading. The article deals with transfer press dies for the production of oil filter shells for the A.C. Spark Plug Div. of General Motors Corp. Should be of great interest to production engineers who are seeking to render their press tool operations automatic."**

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174: 101–103, August 26th, 1954. Mooers, A. B. Transfer devices extend automation in press shop. **"A description of new automatic handling devices in the Buick press shop. Of considerable interest to those operating press plants."**

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49: 186–192, May, 1954. Automation produces refrigerators for Westinghouse. **"A very interesting article, dealing chiefly with the manufacture of refrigerator cabinet and other pressed parts."**

49: 213–218, August, 1954. Renier, W. S. Built-in automation in dieing machines. **"Deals with progressive die operation in stamping operations."**

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83: 699–711, October 9th, 1953. Applications of unit type automatic transfer machines: recent developments at the works of Austin Motor Co. Ltd., Longbridge, Birmingham. **"A thorough description of automatic transfer machines—a valuable article."**

83: 811–813, October 23rd, 1953. Transfer machine for swivel axles. **"Describes in detail the operations on a swivel axle for a motor car. It is a difficult component to hold and locate. Of particular interest to those who wish for precise information on machining on transfer equipment."**

84: 315–324, February 12th, 1954. Special purpose machine for diesel engine production: some examples at the works of F. Perkins Ltd., Peterborough. **"Deals with a number of automatic transfer machines in considerable detail."**

85: 396–398, August 20th, 1954. A Canadian transfer machine. **"A well illustrated article describing a 15 station auto-transfer machine using fixtures to carry the work piece. The fixture return, clearing and loading stations are shown."**

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(*concluded on page* 84)

A JOB EVALUATED WAGES STRUCTURE

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Presented to the Birmingham Section of the Institution, 20th October, 1954.

Mr. Marland

Mr. Marland is a graduate of Manchester University, following which he was engaged with Messrs. Ferranti, Limited, on design and experimental work in connection with large power transformers.

In 1933 he joined the Suffolk Iron Foundry, Limited, as Production Engineer, and the following year he was appointed General Manager. Four years later he was invited to become Works Manager of Messrs. Mirrlees, Bickerton & Day, Limited, at their diesel engine works at Hazel Grove, Stockport.

Early in 1943 he was appointed Works Manager with Messrs. John Wright & Co. Ltd., one of the principal firms in the Radiation Group. In 1949 he was made Works Controller and was recently elected to the Board.

He is a member of the Birmingham Section and Midland Regional Committees of the Institution, in addition to serving on the Research Committee, Materials Handling Sub-Committee, and Materials Utilisation Sub-Committee, and was recently appointed to the Institution's Organising Committee for the National Conference, 1955.

Mr. Marland has applied job evaluation and work study to the manufacture of domestic gas cooking appliances, and has also extended job evaluation to include works staff.

A BALANCED wages structure having correct differentials within a given concern, and yet retaining a parity or otherwise desirable relativity with neighbouring concerns, is one of the important basic aims of most managements—more especially if the proposed wages structure can be readily explained to and accepted by all concerned. The technique used to ensure that wage differentials are maintained on a sound logical basis is known as "Job Evaluation".

The choice of a Job Evaluation system will, to a large extent, depend upon the nature of the business. There are four known methods of computing Job Evaluation, being based broadly speaking on two lines of approach, viz.:

(a) by direct comparison—i.e. one job with another ;

(b) by indirect comparison with a predetermined scale.

The four methods are as follows :—

(*i*) *Ranking Scheme* (Direct Comparison)

Job Specifications are written out in essay form and comparisons are made in money. This is a simple scheme and easy to understand, though it has the disadvantage that any committee appointed to implement the Scheme must have a wide knowledge of all jobs—and must be unbiased. There is no record of the judgment process of placing the jobs in order.

(*ii*) *Grading Scheme or Classification* (Indirect Comparison)

All jobs are placed in clearly defined grades, for which purpose the Ranking Scheme can be used.

The Grading Scheme should link up with the Line Organisation Chart, though its limitations are the same as for the Ranking Scheme.

(*iii*) *Factor Comparison Scheme*—(i.e. a development of Direct Comparison)

Each job is broken down into a number of characteristics—jobs being compared with one another for each characteristic—comparison being similar to that for the Ranking Scheme.

(*iv*) *Weighted Points Scheme* (Indirect Comparison)

The points range may vary according to the industry or nature of the business—though each factor must be clearly defined. This is the most widely used method.

The system described in this Paper is rather a combination of the Ranking, Factor Comparison and Weighted Points Schemes, and though designed specifically for works personnel it is equally capable of application, with a suitable change of characteristics, to the commercial office or even to a technical staff.

Procedure in Setting up Job Evaluation

Fundamentally the method of procedure in the introduction of a Job Evaluated Wages Structure may be divided into five stages, viz. :

(a) preparatory research of existing rates ;
(b) preparation of job descriptions ;
(c) setting up an Assessment Committee ;
(d) consideration of the economics of the new wages structure ;
(e) adjustments consequent upon subsequent national awards.

These steps must be completed before the proposed scheme can be agreed with the parties concerned and brought into effect.

The urgency of introduction of a Job Evaluated Wages Structure may arise from an excessive labour turnover, or the need for attracting a better class of labour, or merely to achieve more economical production.

(a) *Preparatory Research*

It may be surprising to realise the large number of different base rates which are existing when investigations relating to the introduction of a Job Evaluated Wages Structure are begun.

Incentive bonuses being usually reckoned on basic rates, thereby bearing no relation to national awards, often result in misunderstandings by operators and certainly in anomalies of standard costs with varying outputs. It is therefore necessary to tabulate the average earnings for each grade of operator and at the same time to realise the different methods of payment by results which may be operating.

From an examination of such data it may be possible to separate the occupations into three main groups, viz. :

1. *Skilled Trades :* being those for which a craft apprenticeship is served.
2. *Direct Production Occupations*—for which no lengthy period of training is necessary.
3. *Indirect Servicing Occupations*, e.g. stores, internal transport, viewing, labouring, etc.

Framework of a Wages Structure

The framework of any new wages structure must inevitably depend upon the prevailing conditions of the individual concern, as well as upon the reasons for the desired amendment. Perhaps the need for a consolidated rate for all purposes, instead of the usual lower base rate to which is added the national bonus, may be a sufficient justification for a management embarking upon a new wages structure.

The example below illustrates the comparative definitions of the usual method of rating as compared with the consolidated rate method.

(*i*) *Usual Method of Rating*

Total Rate=Rate for the job+national bonus award ; for instance, may be=61/6+28/6=90/-.

N.B.—Bonus or other incentive, together with overtime and holiday credit pay is reckoned on the base rate only.

EXAMPLES OF THE FOREGOING GROUPING—WITH PROBABLE DIFFERENTIALS

Wage Level Grade	Occupational Group No. 1 Skilled				Occupational Group No. 2 Direct Productive					Occupational Group No. 3 Indirect Servicing			
	Tool-maker	Pattern-maker	Elect-rician	Mill-wright	Plate Moulder	Paint Sprayer	Capstan Operator	Press Operator	Assembler	Viewer	Store-keeper	Internal Transport	Labour-ing
1	A	A											
2	B	B	A										
3			B	A									
4				B	A								
5					B	A				A			
6						B	A	A		B			
7							B	B	A	C			
8									B		A		
9											B	A	
10												B	A

A, B, C, signify different gradings under a given type of occupation.

(*ii*) *Consolidated Rate Method* (using the above example) :—

Rate for the job=90/-, i.e. the total and only rate for each job on which bonus incentives and all other items mentioned above are computed.

Advantages of consolidated rates arise from :—

1. Low base rates result in low piecework earnings.

2. Labour may be more readily attracted by the higher consolidated rate on which piecework is reckoned.

3. Operators may find it easier to reckon earnings when piecework is calculated on a consolidated rate instead of on a base rate to which must be added a national bonus award.

It may be of interest to learn that one survey of preliminary research prior to the formulation of a new wages structure based on consolidated rates, revealed the following :—

(a) 70 different basic rates, all in accordance with national agreements.

(b) 195 occupational groupings—these were reduced ultimately, by the new wages structure, to 35.

(c) The normal bonus of 50% on base rates was generally unacceptable and in consequence many anomalies had been introduced which resulted in bonus earnings varying from 63% to 207%.

There are, however, two main principles relating to any new wages structure, which must be clearly understood, viz. :—

(i) the new structure should be easily understood and accepted by all employees if the scheme is to be successfully introduced ;

(ii) formulation of wages policy and decisions on matters connected with it are entirely Management responsibilities.

True standard times should be established as a necessary preliminary to the successful introduction of a new wages structure. This may necessitate a review of or even the initiation of work measurement in order that the new rates and standard times may be introduced simultaneously. It is also advisable that one executive should be made responsible for ensuring general compliance with a new wages policy once it has been introduced.

(b) *Preparation of Job Descriptions*

It is first necessary to understand very clearly the qualifications necessary for each occupational grouping and therefore Job Descriptions are prepared on the basis of a direct shop floor Job Analysis—an example of which is given in Table 1.

The completion of Job Descriptions and Analyses for all jobs in the various occupational groupings enables a comprehensive Job Assessment to be made for which the following information may be of guidance.

TABLE 1 : EXAMPLE OF A JOB ANALYSIS.

TITLE: Millwright—Grade A. JOB NO. 123.

BASIS OF PAYMENT (EXISTING) : Daywork. (No bonus.)

JOB DESCRIPTION :

A man in this grade must be capable of physically undertaking work comprising the installation of machine tools, electric motors, compressors, presses, runways, hoists, etc., working to layout drawings and must have had continuous practical experience over at least six years in such work as :—

Installation and maintenance of pumps.

Maintenance of hoists, cranes and general lifting gear.

Refitting bearings in electric motors.

Testing thermostatic controls.

Balancing of fans.

Making and fitting keys and feathers.

Skill and experience requirements	General knowledge of maintenance work and the ability to improvise where necessary in effecting a speedy repair.
Complexity of work	Very complex—involving a working knowledge of the plant and equipment in every dept.
Training period	5 year apprenticeship and 5 or 6 years further practical experience in maintenance work.
Responsibility	General instructions from chargehand.
Conditions of work	Dirty, arduous, often involving physical discomfort and irregular hours.
Mental requirements	Ability to work with others as a team and that effective maintenance may often avoid costly breakdowns.
Physical requirements	Often heavy, requiring abnormal effort and risk of accident.

Studied by..... Date.....

General Rules relating to Job Assessment, for use in conjunction for instance, with the Factor Definitions as outlined in Appendix I.

(a) It is essential to remember that it is the job and not the person that is to be assessed.

(b) Before commencing an assessment the Job Description should be clearly understood.

(c) The factors of the Job Assessment should apply to the average operator.

(d) No points should be awarded for a factor which is not applicable to the job in question.

TABLE II—JOB EVALUATION—RELATIVE ASSESSMENT EXAMPLES BY FACTOR COMPARISON

Factors No.	Description	Points Range	Tool Maker	Mill-wright	Paint Sprayer	Press Operator	Internal Trans.
1	Previous experience	0–28	28	24	12	12	2
2	Learning Period	0–12	8	5	12	12	4
3	Reasoning Ability	0–23	16	7	4	4	2
4	Complexity of Process	0–11	7	3	2	2	0
5	Motor Accuracy	0–14	9	12	4	4	4
6	Responsibility of Materials	0–6	3	3	1	2	0
7	Effect on Subsequent Operations	0–8	8	2	0	2	0
8	Responsibility for Equipment	0–10	3	6	2	4	0
9	Other Workers	0–3	0	2	0	0	0
10	Attendance to detail	0–4	4	2	1	1	0
11	Attention to Orders	0–12	12	6	0	0	0
12	Monotony	0–5	0	0	3	3	0
13	Abnormal position	0–5	0	4	1	1	3
14	Abnormal effort	0–10	3	6	0	0	5
15	Disagreeableness	0–14	0	8	4	2	5
16	Accident	0–9	4	7	3	5	3
17	Internal Injury	0–5	1	5	1	1	5
18	Disease	0–6	0	3	6	1	0
	Total :		106	105	56	56	33

Example—See Table II, of Relative Assessment examples by Factor Comparison (above).

Factor Degrees

It is often considered desirable to introduce more than one grade with many of the job assessments, particularly with those relating to the skilled occupations. The range of factors for the different grades is sometimes arranged in geometrical progression, e.g. 20, 40, 80 for three degrees. Thus each factor may be similarly considered for each job assessment thereby resulting in two or more grades with corresponding variations in the consolidated rates. By this means a form of incentive or merit rating may be established.

The five jobs selected cover a diversity of occupations and it may be interesting briefly to compare the result of the factorisation. That a paint sprayer and a press operator should be assessed equally is perhaps not as surprising as to realise the equality of evaluation between the toolmaker and the millwright.

(c) *Setting up an Assessment Committee*

It is considered advisable that a small committee should be appointed to prepare the relative, assessment of all jobs from the Job Descriptions which may also be prepared, with advantage, by the same committee.

The constitution of this committee should be effected with much care and the inclusion or otherwise of workers' representatives must be left to the discretion of the management.

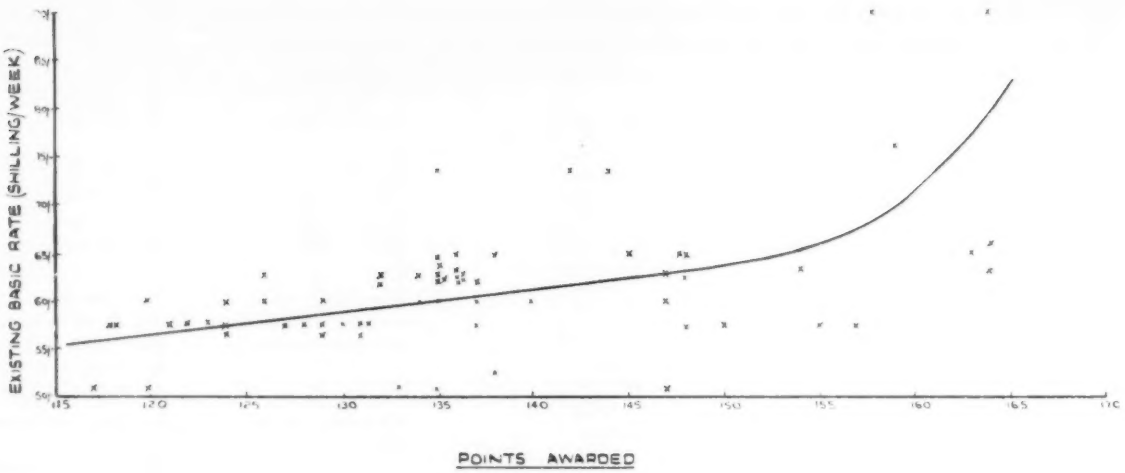
A typical committee might include e.g. :—

1. Works Manager or similar executive.
2. Industrial or Planning Engineer.
3. Personnel Officer.
4. Foreman of the department concerned.
5. Workers' representative of group being studied.

Upon the assiduity and impartiality with which this committee functions will largely depend the success of the new wages structure, and no effort should be spared in exercising accurate and impartial judgment. Thereby it becomes eventually possible to compile a list of all jobs together with their relative assessments. A few examples of this work are given herewith.

(d) *Consideration of the Economics of the Proposed New Wages Structure*

When all jobs have been assessed and their relative evaluation determined it is necessary for the manage-



ment of the Company to consider the economics of the proposed new Wages Structure and to lay down in general terms, the relationship between the old and the new methods.

For this purpose it is helpful to prepare a graph (see example above) of the existing rates relative to the respective points assessment for the various occupational groupings. From the example it will be noticed that existing basic, daywork and piecework rates are plotted as ordinates on a base of points assessment.

The results may, of course, vary somewhat with different concerns, though generally speaking it may be expected to conform to a similar pattern as illustrated. By taking widely separated points on each curve the value of "*the average labour cost per point value of assessment*" may be determined. This evaluated figure may then be compared with that computed from a division of the total wages and the number employed.

The decision to plan the proposed new wages structure on a curve or a sharply inclined line giving a high differential between skilled and unskilled jobs, will naturally depend upon the limitations placed upon the Company by industrial agreements.

The fact that all jobs have been evaluated relatively equitably provides a basis upon which a management can review and determine the policy of awarding any increase by means of consolidated rates. The amount awarded may be influenced by local conditions, labour turnover or the need to attract a better class of labour.

Whatever the reason, no change ought to be made until the total cost involved by the new proposals has been ascertained. In the actual survey previously referred to and from the research data obtained, consolidated rates slightly in excess of existing gross rates were proposed which when compared with present earnings revealed the following :—

34% would be underpaid by more than 10%
56% appeared proportionally paid within ± 10%
10% would be overpaid by more than 10%

If an inducement is offered then it may be advisable to re-study some or even all of the operations involved, in order to effect economies in methods which would offset any additional cost of the new wages structure. On the other hand, the proposed inducement may result in increased output with a consequential reduction in oncosts sufficient to compensate for the additional direct labour cost.

Such questions must be left for individual consideration at Board level—one suggestion, however, may be made in cases where labour turnover is excessive. That is, to estimate the total cost involved in training labour having regard to factors such as :—

(a) value of scrapped work ;
(b) disorganisation caused by changes of personnel;
(c) supervisory or other costs of training.

Incidentally, again referring to the example previously quoted, after six months during which five departments were changed over to the new consolidated wages structure, the following results were revealed :—

(i) 27% less labour required for the same output ;
(ii) average productivity increased by 38% ;
(iii) average earnings increased by 7½%

(e) *Adjustments Consequent upon Subsequent National Awards*

While national awards are usually related to basic rates, then only a proportion of the award may need to be added to the new consolidated rates *pro rata* to the various grades, relative to the award.

For example, in 1952 the Confederation of Shipbuilding and Engineering Unions, in conjunction with the Engineering Employers Federation, agreed to an increase of 7/4d per week of 44 hours to all adult manual workers. This figure of 2d per hour was added

to the consolidated rates for timeworkers, whilst for pieceworkers it was added to the appropriate money bonus, so that the final result should not exceed the 2d per hour increase. Thus, for example, in the case of pieceworkers earning an average of 30% on the consolidated rates, 1½d was added making up to the agreed 2d with normal piecework earnings.

The adjustment proposed, however, should at once be discussed with each section of the labour personnel concerned especially to ensure that all suspicion of exploitation is eradicated. It should be possible to negotiate for only a proportion of the award where the consolidated rate is already in excess of the basic rate plus cost of living bonus.

Implementation of the Proposed Scheme

Having determined the framework of the new wages structure on an economic basis, it is necessary to decide upon the method of introduction in connection with which due regard should be given to the following :—

(a) notification of intention to employers' association in the case of a Federated Company ;
(b) preparation of a statement of Company policy to be issued in sequence as follows to :—
  (i) Departmental Managers, Foremen and Chargehands.
  (ii) Trade Union (District Officials) simultaneously to employees' representatives ;
(c) Preparation of a Code of Rules for the operation of the New Wages Structure—covering all eventualities.

(a) *Notification of Employers' Federation.*

In determining the framework of the New Wages Structure, due regard should be given to the notification by a Federated Company of the proposals to its relative Employers Association.

This should be done quite openly, not with the intention of contravening existing agreements but with a desire to obtain parity of rates within a given concern and/or with the object of attracting labour to a district in which there is keen competition for all grades of labour.

(b) *Statement of Company Policy.*

Such a statement should define clearly and concisely the reasons for the proposed new Wages Structure, and the advantages afforded to the employees as well as to the Company.

It should also define briefly the method of Job Evaluation in terms which may be readily understood by all employees. In particular, the Statement should reiterate the guarantee of Time Standard, viz: "that no alteration will be made in any time standards", unless there is :

(a) a change in method, materials or equipment ;
(b) by mutual agreement with the employees concerned.

(c) *Code of Rules.*

With the issue of a clearly defined statement of Company policy should be an equally simple Code of Rules. Moreover, the implementation should be entrusted to one executive, who must be prepared patiently to explain to the personnel or each department in turn just how the proposals affect each individual. Care should also be taken to absorb labour made redundant in any one section into another section as rapidly as possible.

By this means, confidence in implementation may be assured, since it is almost inevitable that increased output will result once the incentives of the Scheme have been fully realised by the labour personnel.

No effort should be spared to ensure that employees fully understand the scheme so that all elements of suspicion can at the outset be removed. If the job is tackled with complete sincerity of purpose then industrial relations may even be improved, for with a carefully prepared scheme, benefits should be forthcoming for the employee as well as for the Company.

A Code of Rules should be drawn up, discussed with the workers' representatives and issued in relation to each department separately according to the various occupational groupings. (See Appendix II).

Copies of the Code of Rules may be circulated to all Supervisory Grades, departmental representatives of the Trade Unions and displayed on the respective departmental notice boards for the attention of all employees.

As previously stated, it is advisable that one executive should be made responsible for ensuring the general compliance with the Company's policy in respect of its New Wages Structure. To this executive should be delegated the duty of explaining both the Statement of Company Policy and the Code of Rules carefully to each department, group of operators or even to individual employees. Much care and patience should be exercised in this task, for it is essential to convince employees of the sincerity of purpose on the part of the management.

Examples of earnings possible by consolidated rates as compared with those existing, should be clearly understood by all employees. Incidentally it should be explained how lateness, for example, would involve an operator in greater loss financially on a consolidated rate than on the lower basic rate. On the other hand overtime and holiday pay can, of course, be calculated on the enhanced, i.e. the consolidated, rate.

Review of Results of the Scheme

With the introduction of a Job Evaluated Wages Structure it is well to review from time to time the results which, it is suggested, may be measured by the following factors computed departmentally :—

(a) comparison of labour turnover with output attained before and after the introduction of the Scheme ;
(b) records of departmental productivity increases from an assessment of Productive Indices ;
(c) comparative earnings before and after the introduction of the Scheme ;
(d) overall savings in direct labour costs.

Sincerity of purpose, a willingness at all times to explain to an individual operator just how the scheme functions, and complete impartiality and fairness of administration are factors so very important towards the successful introduction of a Job Evaluated Wages Structure. Once the idea has "caught on" in one or two departments, it may be expected that applications to be included will be made by other sections.

Provided that the proposed scheme readily

indicates a reasonable incentive, then lower costs of production should soon result from increased output. Further, it may be expected that labour turnover may decrease and stability of labour conditions be enhanced, so that the ultimate of direct labour savings may be appreciable.

Records should be kept and reviewed regularly for each section participating in the Scheme, as well as to observe the enthusiasm which the introduction of the Scheme has promoted. Records should also be kept of departmental productive indices and compared with those prior to the introduction of the Scheme.

Finally, it is to be expected that with the introduction of increased rates by consolidation, Managements and in particular Planning Department Staffs, will be anxious to develop work study as fully as possible so that still further economies may result.

In conclusion it is hoped that sufficient interest may have been stimulated to indicate to Managements the desirability of having a balanced wages structure with correct differentials within its own concern.

APPENDIX 1

FACTOR DEFINITIONS FOR MANUAL JOBS IN AN ENGINEERING WORKS APPLICATION

1. Previous Experience — *Range 0-28 points*

Is previous experience necessary, e.g. a recognised apprenticeship?

Two points per year for ordinary workshop experience and four points for each year of apprenticeship may be awarded up to a maximum of 28 points.

2. Learning Period — *Range 0-12 points*

The time required for a new operator to become familiar with the new surroundings and to earn a minimum wage for the job, e.g. 1 point per week up to a maximum of 12.

3. Reasoning Ability — *Range 0-23 points*

A measure of the judgment required and the ability to recognise that the job is being done correctly.

Average repetitive... ...	0-4 points
Accurate repetitive ...	5-8 ,,
Accurate (limited variety)	9-16 ,,
Experimental	17-23 ,,

4. Complexity of Process — *Range 0-11 points*

The extent to which the operation requires the mastery of an unusual number of details, or the memorising of large numbers of variations.

Repetitive work	0 points
Machining (Special)—small quantities	0-3 ,,
Toolroom machining ...	4-7 ,,
Intricate assembly, e.g. telephone switchboard wiring	8-11 ,,

5. Manual Dexterity or Motor Accuracy — *Range 0-14 points*

Jobs requiring unusual quickness or deftness, close timing of limbs or close co-ordination of the senses and the muscles.

Machine minding... ...	0 points
Machine operating ...	0- 4 ,,
Strickle moulding or instrument assembly ...	5- 9 ,,
Overhead electric wiring or fine glass blowing ...	10-14 ,,

6. Materials — *Range 0-6 points*

Potential damage to materials or components (not tools or equipment) :—

(a) By one action value under	£1	0 points
	£20	1 ,,
	over £20	2 ,,
(b) Total value of material that can be lost through carelessness in one day	under £5	0 point
	under £100	1 ,,
	over £100	2 ,,

(c) To what extent do existing inspection methods prevent any loss.

Do prevent	0 point
Have influence	1 ,,
Cannot prevent	2 ,,

7. Effect on Subsequent Operations — *Range 0-8 points*

To consider whether lack of care might make work on subsequent operations more difficult or might necessitate additional operations. This factor is influenced by inspection, the absence of which may involve a high degree of responsibility.

Rough machining or spray painting—low	0-2 points
Sub-assembly—medium ...	3-5 ,,
Inspection or marking off high	6-8 ,,

8 Equipment — *Range 0-10 points*

This refers to damage that can be caused to machines or equipment through lack of operational care. The value of the damage is not necessarily the value of the equipment.

For guidance : Award 1 point for each £1,000 of damage up to 5 points.

Risk of possible damage ...	0-3 points
Extent of production affected...	0-2 ,,

9. Teamwork—i.e. close co-operation and adjustment of movement with other workers :— *Range 0-3 points*

No. in gangs	*Points*
2	1
5	2
10 or more	3

10. Alertness to Detail — *Range 0-4 points*

The extent to which alertness or concentration is required to do the work successfully.

Machine minding	0 points
Machine operating	1 ,,
Viewing for blemishes	2 ,,
Sorting into types	3 ,,
Checking	4 ,,

11. Attention to Orders — *Range 0-12 points*

The extent to which the job necessitates an ability to follow the details of a written order, job specification or drawing.

All repetitive work with long runs	0 points
Occasional reference to simple orders or drawings	1-4 points
Occasional reference to complicated orders or drawings or constant reference to simple orders or drawings	5-8 ,,
Constant reference to complicated orders or drawings	9-12 ,,

12. Monotony — *Range 0-5 points*

To consider if the job is unusually tedious or irksome :—

(a) When the total time for the operation is extremely short and the batch of parts very great.

(b) When intense and continual visual attention is necessary on a very limited variety of work.

(c) Monotony can be caused when the work demands only a small amount of body movement.

If the job conforms to all three of the foregoing items, then the maximum of 5 points should be awarded.

13. Abnormal Conditions — *Range 0-5 points*

Consider whether any unusual cramped position tends to strain certain muscles to an abnormal degree.

Standing—with little body movement	0-1 point
Frequent stooping or reaching	2-3 ,,
Continual stooping and reaching or the confinement of the body in an awkward position ...	4-5 ,,

14. Abnormal Effort — *Range 0-10 points*

To consider whether the work is heavy to such an extent that the job is unattractive or that unusual physical strength is required.

Lifting 20 lb. frequently or 50 lb. occasionally— Low ...	0-3 points
Lifting 50 lb. frequently or 100 lb. occasionally—Medium	4-7 ,,
Lifting 100 lb. frequently or 175 lb. occasionally—High ...	8-10 ,,

15. Disagreeableness — *Range 0-14 points*

The degree to which the job is made particularly unpleasant by the presence of dust, fumes, wet, heat, cold or excessive noise.

Assembly work		0 points
Machine operating—Low ...		0-2 ,,
Outdoor Work (unsheltered), Polishing, Plating	Medium	3-5 ,,
Fettling or Powder Milling—High		6-8 ,,
Hand Furnace stoking, Shotblasting (inside a cabinet)	Very high	9-14 ,,

16. Accident — *Range 0-9 points*

Degree of potential risk of accidents and possible severity of injury to the operator—graded :—cuts and bruises (low), broken limb (medium), disablement (high).

Risk of Accident	*Severity of Injury*	*Points*
Nil	—	0
Low	Low	3
	Medium	5
	High	6
Medium	Low	4
	Medium	6
	High	8
High	Low	6
	Medium	8
	High	9

17. Internal Injury — *Range 0-5 points*

To consider whether the requirements of the job offer possibility of hernia or bodily strains. This factor will be affected by the " Abnormal Effort " required.

Low	0-1 points
Medium	2-3 ,,
High	4-5 ,,

18. Disease — *Range 0-6 points*

To consider to what extent the working conditions are harmful to health, are conducive to occupational disease, e.g. dermatitis, silicosis, lead poisoning, etc.

Low	0-2 points
Medium	3-4 ,,
High	5-6 ,,

APPENDIX II

CODE OF RULES

Each departmental document should contain the following information :—

1. Departmental hourly rates payable for all productive and non-productive grades of labour, i.e. male and female, adults and juniors who are working in the department.

2. A statement that the consolidated rates are the basis of payment for :—

(a) All hours worked.

(b) Overtime premiums.

(c) Night shift, double day shift or three shift preminums.

(d) The six paid Bank or other statutory holidays.

(f) Guaranteed week.

3. The given rates are the basis of payment for all minutes earned on work for which standard times have been set under the New Wages Structure and which is work normally done by the Department.

4. Trainees' earnings will be made up to the consolidated rates until their earnings for good work done exceed the consolidated rate.

5. Special work, i.e. other than that connected with normal duties, will be paid for at consolidated rate plus $\frac{1}{6}$th ($16\frac{2}{3}\%$) provided that the period of duration of the special work does not exceed two days in any one week.

6. New Products—On the introduction of a new model the first production batch will be regarded as tool trials and no standard times will be issued. Operators will be paid consolidated rates plus $16\frac{2}{3}\%$ for the first batch, after which Job Specifications and Rate Forms will be issued for standard times which will operate for a period of not less than three months.

7. Once a Rate Form has been issued no alteration will be possible unless by mutual agreement or a radical change in method.

8. Waiting Time and Abnormal Conditions which are not the responsibility of the operator will be paid for at piece rate time plus one-sixth.

9. Rectification of work will be paid for at consolidated rates only.

10. Job Specifications must be precisely adhered to and no departure whatsoever is permitted without the authorisation of the Planning Department.

11. Apprentices who are indentured are not affected by the new wages structure and will continue to be paid the apprentice rate under the appropriate Federation agreements.

12. Transfers :

(a) Any operator transferred to a higher rated job will immediately be paid the consolidated rate for that job plus any bonus earned on standard times.

(b) Any operator transferred because of redundancy or because of unsatisfactory workmanship will be paid the consolidated rate applicable to the new job plus any bonus earned on standard times.

(c) Any operator temporarily transferred to suit the convenience of the Management will continue to be paid on the previous consolidated job rate for a period of four weeks, if, otherwise, the transfer would result in a reduction of consolidated rate.

13. Lateness—a deduction will be made at the consolidated rate for lateness, with a minimum deduction of a quarter of an hour.

Examples of earnings possible by consolidated rates as compared with those existing, should be clearly understood by all employees. Incidentally it should be explained how lateness, for example, would involve an operator in greater loss financially on a consolidated rate than on the lower basic rate. On the other hand overtime and holiday pay will, of course, be calculated on the enhanced i.e. the consolidated rate.

" Cooling and Lubrication of Sendzimir Mill "

(concluded from page 119)

arranged to encourage the settling out of water and some of the suspended solids. After settling the oil passes over a weir into the suction compartment.

The bag filters pump takes oil from the suction compartment and delivers it at up to 20 lb. per sq. inch to the bag filters. When clean, each bag filter will take full flow.

After passing through the filter bags, the oil falls by gravity into the clean oil tank.

A proportion of the oil (about 10%) is taken from the clean oil tank and is passed through the two P91 stream-line filters, removing every trace of impurity from this proportion of the oil before returning it to the tank.

One of the main circulating pumps takes the clean oil from the clean oil tank and delivers it through the coolers to the mill sprays at a pressure of 150 lb. per sq. inch. A branch in the main takes a part of the oil to the mill bearings *via* a pressure reducing valve supplying at 20-30 lb. per sq. inch.

The main circulating pump is manually controlled, but the reserve pump is started automatically by a fall in the pressure in an air vessel in the main supply pipe.

Coolant is drawn from the main storage and settling tank by one of the duplicated circulating pumps and is delivered through the cooler to the header tank. From this tank the coolant flows by gravity to the mill as required, any surplus returning to the main storage tank *via* the overflow pipe.

From the mill the coolant returns to the collecting tank by gravity and is then pumped into the receiving tank by the float operated return pumps. From the receiving tank the coolant is distributed to the bag filters and after filtration is discharged into the main storage tank.

Two skimmers in the main storage tank will remove any oil from the surface of the coolant. This may be run off into a storage tank where any remaining soluble oil is allowed to settle.

RESEARCH PUBLICATIONS

A number of copies of the following Research publications are still available to members, at the prices stated :

Report on Surface Finish, by Dr. G. Schlesinger	15/6
Machine Tool Research and Management	10/6
Practical Drilling Tests	21/-

These publications may be obtained from the Production Engineering Research Association, " Staveley Lodge ", Melton Mowbray, Leics.

Correction

Members are asked to note that enquiries regarding courses in work study, referred to on page 687 of the December issue of the Journal, should be addressed to the individual colleges concerned, and not only to the College of Aeronautics, Cranfield.

MODERN COLD ROLLING MILLS

by G. W. ASHTON

Presented to the Sheffield Section of the Institution, 26th October, 1953.

Mr. Ashton

After serving his apprenticeship with Messrs. Thos. Firth and Sons, Ltd., Sheffield, Mr. Ashton spent seven years in the Brown Firth Research Laboratories. In 1932, *he joined Messrs. Hall & Pickles, Ltd., and laid down a wire drawing and wire rolling mill plant of which he was appointed manager.*

In 1943 *he joined Messrs. Samuel Fox & Co. Ltd., as Technical Assistant and Production Engineer to the General Works Manager, and in this capacity was largely responsible for the installation and starting up of fine wire mills, cold rolling mills, continuous heat treatment plant and specialised watch and clock spring production.*

In 1947 *Mr. Ashton was appointed a member of the Joint Technical and Advisory Committee set up by Messrs. Firth-Vickers Stainless Steels, Ltd., and Messrs. Samuel Fox and Co. Ltd., to put down the buildings and plant now known as The Shepcote Lane Rolling Mills, Ltd., following which he was subsequently promoted to his present appointment as Superintendent in charge of these Works.*

I am afraid that the title of this lecture may be somewhat misleading, as I do not intend to refer to cold mills in general, but specifically to two modern reversing mills which have recently been installed in the Shepcote Lane Works of Messrs. Firth-Vickers Stainless Steels Limited. One of these is an orthodox 4-high mill of English manufacture, and the other a Sendzimir mill of American manufacture, and this is the mill upon which I intend to concentrate. Both mills are doing more or less the same operation, and I had hoped to be in a position by this time to give comparative roll costs, and so on, but unfortunately constant delays in delivery and starting up of the plant have brought the completion date so far behind schedule, that we have been unable to obtain sufficient data to give reliable figures at the moment.

As the mills are to some extent tied up with other plant, it may be necessary to make some reference to recoiling and descaling lines. The Shepcote Lane plant was put down for the production of stainless steel sheet up to $40\frac{1}{2}''$ wide in continuous lengths of 5 tons on the full width. Narrower sizes are proportionally less in weight.

Fig. 1 shows a reversing mill with roll sizes of $17'' \times 40'' \times 50''$ wide, with a maximum speed of 800 f.p.m. Constant tension is available on both sides of the mill to a maximum of 33,000 lb. Hydraulic roll balance is used incorporating oil at 2,000 lb. per sq. in., and the mill is powered by a 1,500 h.p., main mill motor, with 600 h.p., on each coiler motor. The mill motor gives constant torque to base speed of 400 f.p.m., and constant h.p., to 800 f.p.m. Coil motors are constant torque throughout the speed range. Screwdown motors are 40 h.p.

Fig. 2 gives a general view of the mill in question, and it will be seen that the layout incorporates a cone type uncoiler and roller leveller on one side of the mill and an upcoiler on the other side. Two falling tables project over the coiler drums so that the mill can be used as a straight through single pass mill, taking from the uncoiler at one side and delivering an open centre coil in the upcoiler at the other side. For

Fig. 1.

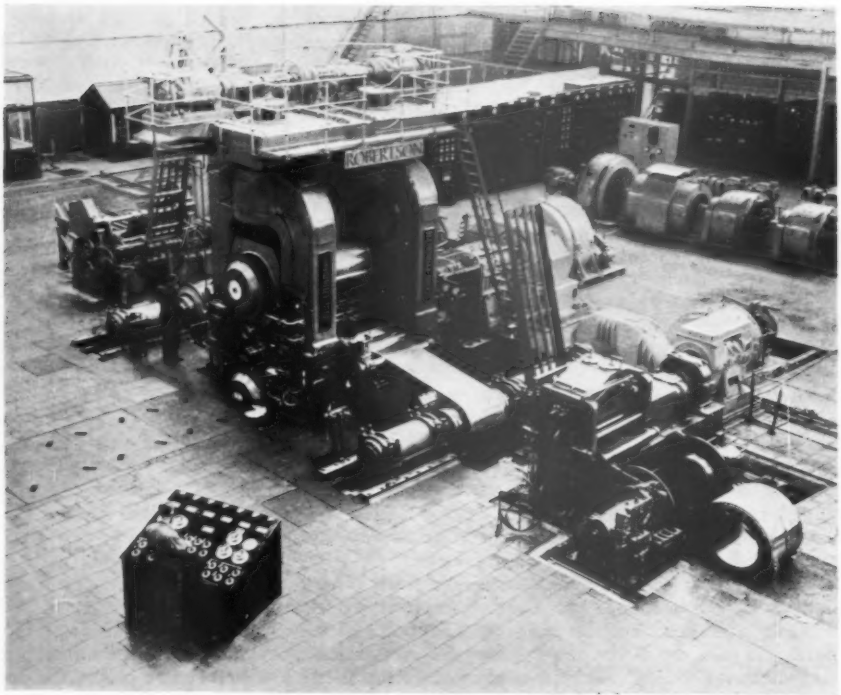


Fig. 2.

the first pass where no back tension is available on the strip, pressure plates and side guides are essential.

Fig. 3 shows the entry guides as fitted to the mill. The top and bottom plates are of wood with brass side guides, and are moved into position and loaded by compressed air. It is used for the first pass only, and opened out for all subsequent passes. For normal operation the falling table on the right-hand side is dropped, and the incoming strip is fed from the coiler and leveller through the mill to the left-hand coiler, and the first pass is made. When this pass is completed the right-hand table is lifted, and the strip attached to the right-hand coiler, and rolling under controlled tension commences. It will have been seen from Figs. 1 and 2 that two control desks are used, one on each side of the mill. These are identical and arranged so that the man at the control desk can see the outcoming strip.

Fig. 4 gives a close-up view of one of the control desks.

The mill has Robertson hydraulic bearings on both backing rolls and work rolls, with a roller thrust race on the working side of the work rolls. The housings are capable of taking a strain of 1,000 tons each, and the roll assembly is cooled by an 8% soluble oil mixture. (*See Fig. 17*)

The coolant system contains 9,700 galls., and gives a delivery of 280 galls. per minute of filtered oil at a constant temperature. The mill has proved very satisfactory and is capable of producing 55% to 60% reduction between anneals of austenitic stainless, and up to 80% reduction between anneals of ferritic stainless. Maximum reduction per pass is 15%-20% falling, as maximum hardness is reached, to about 3%-5%. It will probably have been noted that the coiling drums are somewhat unusual in design, but I propose to refer to these in detail when we come to the Sendzimir mill, as the coiling layouts are identical.

The Sendzimir Mill

I do not know if the audience is familiar with this type of cold mill, which I think can be best described as a super cluster mill.

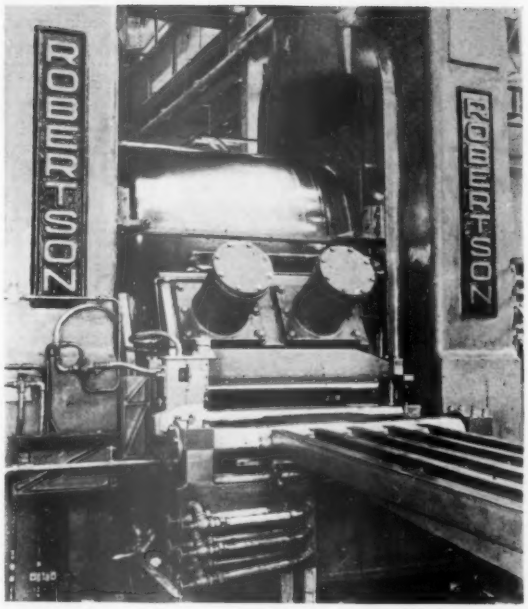


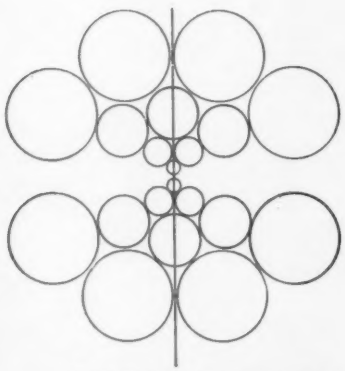
Fig. 3

In Fig. 5 we have a diagrammatic layout of the Sendzimir mill roll set-up. The small pair of rolls are the work rolls, which are backed up by the first intermediate rolls, which are in turn backed up by the second intermediate rolls, which are again backed up by assemblies of roller races which transfer the thrust through saddles to the cast steel housing.

The casting in Fig. 6 forms the basis of the mill and must be accurate to extremely fine limits, as the final alignment of the mill is completely dependent on the accuracy of the housing. Any inaccuracy here would render the mill wild and uncontrollable.

Figs. 7, 9 and 10 give views of the interior of the actual mill, showing the rolls in position. The mill is

Fig. 4



Sketch illustrates how small work rolls are supported by larger back-up rolls in the Sendzimir mill.

Fig. 5

Fig. 6

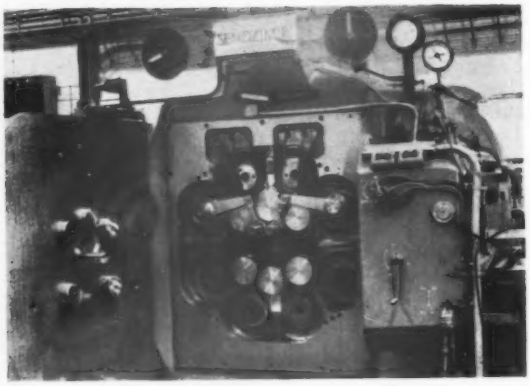


Fig. 7

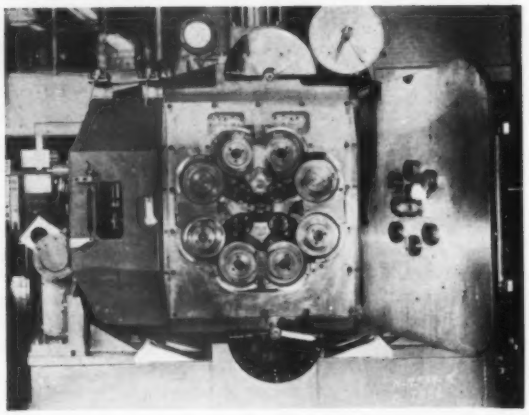


Fig. 8

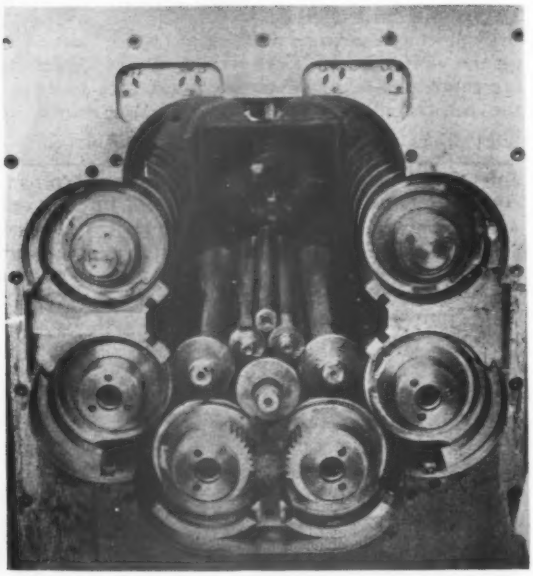


Fig. 9

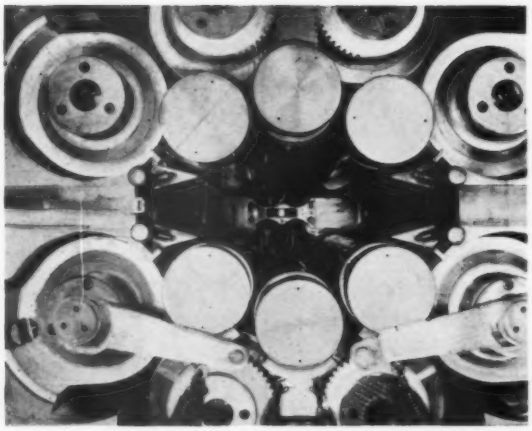


Fig. 10

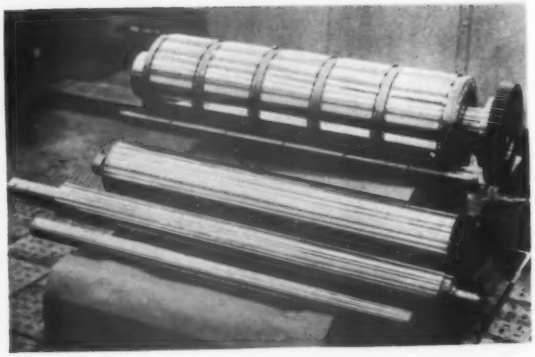


Fig. 11

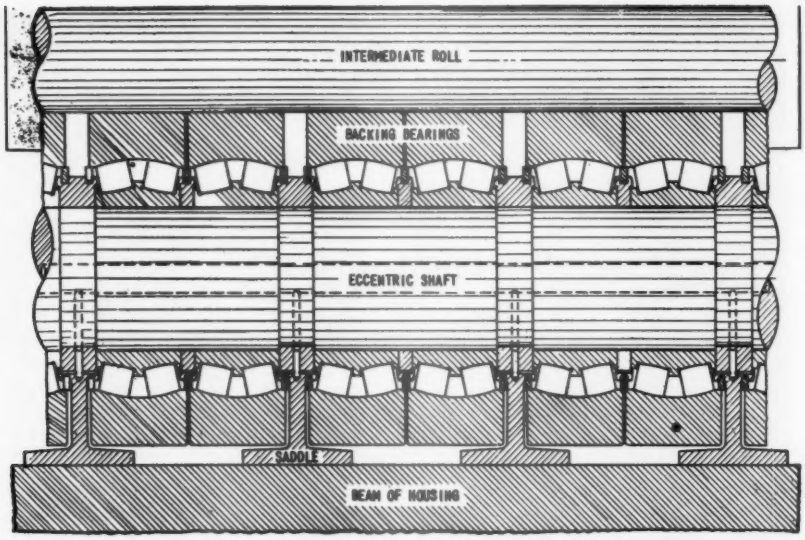


Fig. 12

40″ wide and is of the 1-2-3-4 type, utilising work rolls with a nominal diameter of $2\frac{1}{8}$″, the first intermediate rolls are 4″ diameter, and the second intermediate drive rolls are 6″ diameter.

Fig. 11 shows how the drive is backed up. The whole of the mill loading is then taken by eight bearing assemblies of five roller races, which transfer the load through saddles to the steel casting which forms the mill housing.

The first thing which strikes one on seeing a Sendzimir mill is the comparatively small size as compared to a 4-high mill of similar capacity, and the next thing is that there is no independent adjustment of screwdowns. Screwdown is effected by means of a pair of oil hydraulic cylinders acting through rack and pinion on to eccentrics in the saddles of the two top bearing assemblies. This closes up the work rolls and is absolutely parallel in its action. There is no means of putting more load on one side than on the other, as in the orthodox mill. However, some compensation is provided for over or under rolling on one edge or both, and this is obtained by means of the first intermediate rolls. The top pair of these rolls is tapered off at one end and the bottom pair at the other end, and both pairs of rolls are independently adjustable over a distance of 5″ horizontal travel. (Fig 13)

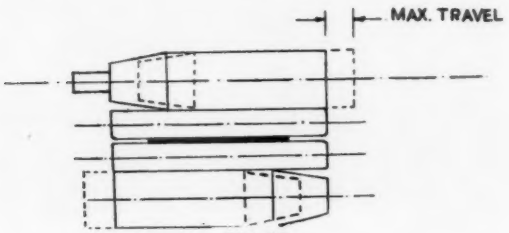


Fig. 13

In practice we have found it necessary to grind and taper the opposite ends of the top and bottom rolls for 8″ at about 3–4 thou. per in., and by suitable manipulation of these tapers it is possible to roll a flat strip with about $2\frac{1}{2}$″–3″ of the taper on each edge of the strip. The reason for the 8″ length of taper is to accommodate various widths of strip. Provision is also made to apply crown adjustment.

The six adjustment screws which can be seen on the mill (Fig. 14) fit through the housing into the saddles in the top right-hand bearing assembly, and each operates an independent eccentric. This enables more pressure to be put on the rolls at any point. However, unfortunately in practice we find that these do not work as well as might be expected and it would seem that the local pressures are lost in housing stretch and

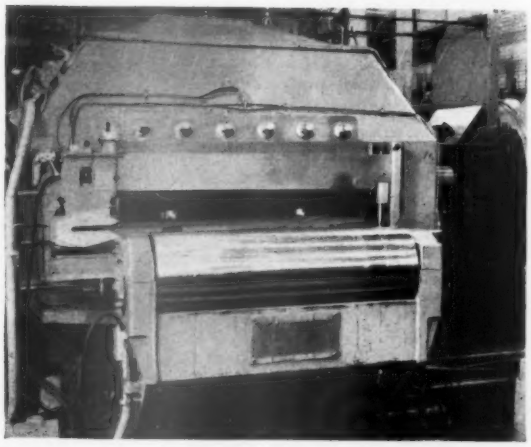


Fig. 14

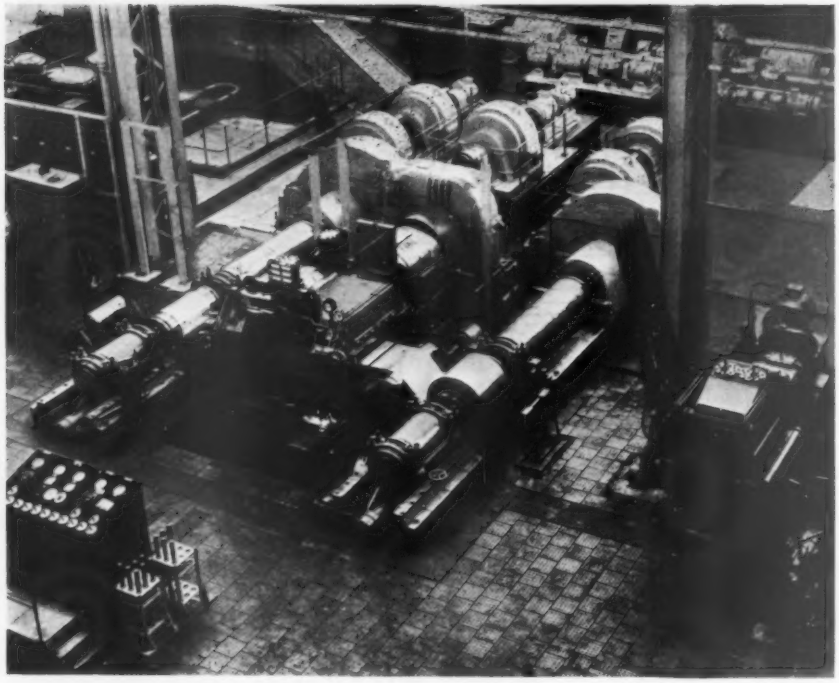


Fig. 15

roll flattening before reaching the work roll. Although claims are made that the mill is extremely rigid and, therefore, flat rolls can be used, we have found that under the high pressures required for rolling work hardened stainless steel, this is not correct and it has been found necessary to camber the six second intermediate drive rolls +5 thou.. Work rolls are also cambered both plus and minus in order to accommodate varying shapes of hot rolled strip. I have already mentioned the method of screwdown and will now explain the setting up of the mill (Fig. 8).

As explained, screwdown is effected by means of eccentrics incorporated in the two top roller race assemblies.

The two bottom pairs of race assemblies are also actuated by hydraulic rack and pinion, similarly to the top screwdown, in order to bring the pass-line level with different diameter rolls. To keep the whole assembly central as roll diameters decrease with grinding, the pair of assemblies on the right-hand and left-hand is also adjustable by means of electric motors operating the eccentrics.

General Layout

Fig. 15 shows a general layout of the mill. The speed is 400 f.p.m., and it is powered by a 600 h.p. mill motor, with constant torque of 200 f.p.m., and constant h.p. to 400 f.p.m.

The coiler motors are double armature motors which develop 430 h.p., at constant torque. The reason for the double armature motors on the coilers is to give a dual tension range in order to cover the wide range of strip sizes. By this means we get two 10–1 tension ranges : one from 3,000 to 40,000 lbs., with one armature in circuit, and others from 25,000 to 65,000 lbs., with both armatures connected. Control is from a single desk centrally mounted. (Fig. 16)

Importance of Tension

You will note that these tensions are very much higher than normally used on a 4-high mill, and we find that it is absolutely imperative to have this very

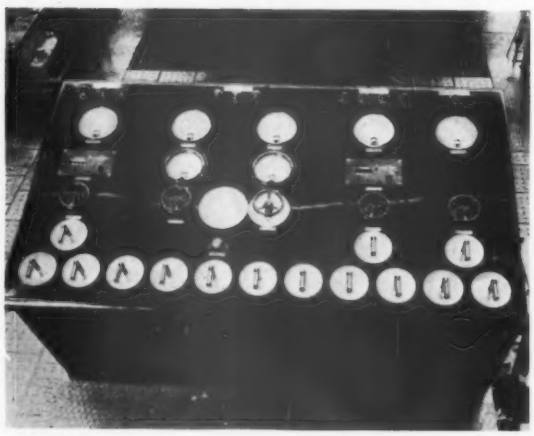


Fig. 16

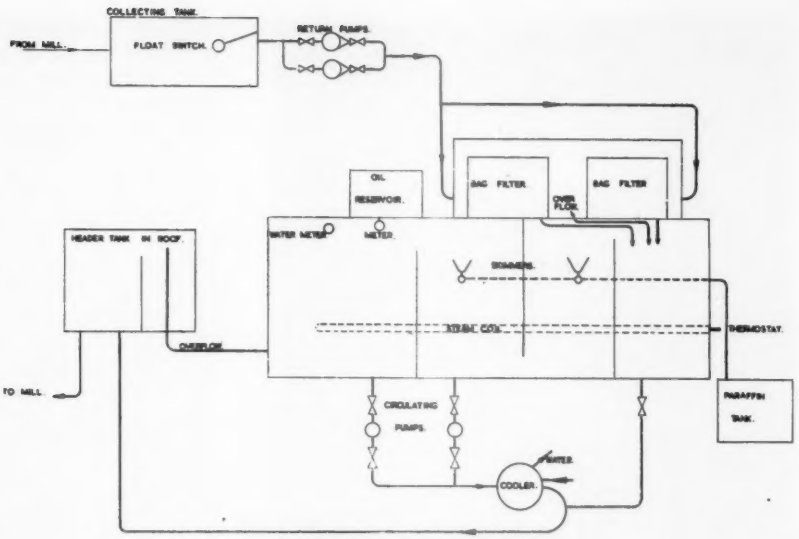


Fig. 17

FLOW DIAGRAM FOR SOLUBLE OIL SYSTEM, ROBERTSON COLD ROLLING MILL.

high tension and to have as near perfect control of it as possible. The mill is completely dependent upon tension for guiding the strip, and this must be centred accurately in the mill, because of the edge compensation referred to previously. A run off of $\frac{1}{4}$" in the coil build-up from start to finish will give trouble from this cause. Any variation in tension during acceleration or deceleration will produce a wobble almost immediately. Reductions per pass on this mill work out best at about 15% to 20%, and we have made total reductions without intermediate annealing on both austenitic and ferritic stainless steels up to 97%. The following tensions are recommended for rolling on the Sendzimir mill :

Low carbon steel : 20,000 p.s.i.
High carbon steel : 30,000 to 40,000 p.s.i.
18.8 stainless steel : 40,000 to 50,000 p.s.i.
17% chrome steel : 20,000 to 30,000 p.s.i.

For this reason both the 4-high and Sendzimir mills are fitted with solid drum coilers, as in view of the

Fig. 18

Fig. 19

extra high tensions required in coiling, we were unable to get any manufacturer to quote us for collapsible drums guaranteed to work satisfactorily under such heavy tensions. It is estimated that at 65,000 lb. tension on a 5 ton 20 gauge strip 40" wide, a pressure of about 50 million pounds is developed. These solid drums are fitted in the coiler drives in a similar manner to the head and tail stock of a lathe with the tail stock hydraulically operated.

The cooling and lubrication of this mill is interesting as the coolant must also be a lubricant, and a mineral oil is used for this purpose (*see end of Paper*).

The oil is delivered into the mill 280 galls. per minute at 120 lb. per sq. in. by two rows of eight jets under and over the strip on each side of the mill, and impinging into the roll bite. A further supply at 20/30 lb. per sq. in. is taken to each spindle of the bearing assemblies, and is fed through the centre of this into each individual roller race. This ensures a good supply of lubricant and also continually washes out the race under pressure, thus preventing the ingress of metal particles shed from the strip during rolling. There are two oil tanks, dirty and clean, each holding 8,000 gallons. (Fig 18)

Comparative Performance

Now that I have given a rough description of both mills we come to the question of comparative performance, and I am often asked which do we find most satisfactory. I think the correct answer to this is that there is a place for both mills; one is better for one job and the other better for another. For instance, on strips which do not require more than 50% reduction the 4-high mill is faster than the Sendzimir mill. If more than this reduction is required, then the Sendzimir mill will continue to roll up to over 90% reduction. As far as stainless steel is concerned, this means a considerable saving in the cost of annealing and descaling which would otherwise be required. Another point is the question of shape, a very vexed question. It is easier to roll a flat strip on the Robertson mill than it is on the Sendzimir, and although the Robertson may lie flatter, upon measurement we find the Sendzimir produces a much more accurate strip.

A cross section of a coil which was cut into two at .130" thickness, and one half rolled on the Sendzimir and the other half on the Robertson mill down to .028", showed a very marked edge drop on the Robertson strip of almost $1\frac{1}{4}$ thou." and even if this is discounted, which means 5" of strip, there is still half a thou. variation across the width giving a total of $1\frac{3}{4}$ thou.". With the Sendzimir rolled strip there is practically no edge droop at all, and only 4/10 of a thou. total variation. It is most interesting, however, to find that although variation on the 4-high rolled material is much higher than that of the Sendzimir, the same general pattern of high points exists, and it would seem that this could be traced back to the shape of the hot rolls.

Better Surface Finish

A further point is that there is much less size variation on the Sendzimir, due to speed changes, than on the 4-high, and that a wider range of size control can be obtained with variable back tension. Much better surface finish is also obtained on the Sendzimir mill, as a newly ground roll can be used for last pass. As regards maintenance of the two mills, I would expect higher costs on the Sendzimir, but reliable figures are not yet available.

A great advantage of the Sendzimir mill is that a supply of shaped work rolls can be kept at hand. and any particular shape or combination of shapes can be put into the mill in a few seconds, as it is not

SENDZIMIR MILL BACKING ROLLS.

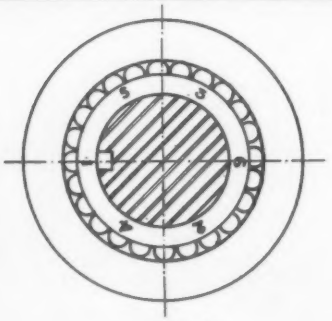


Fig. 20

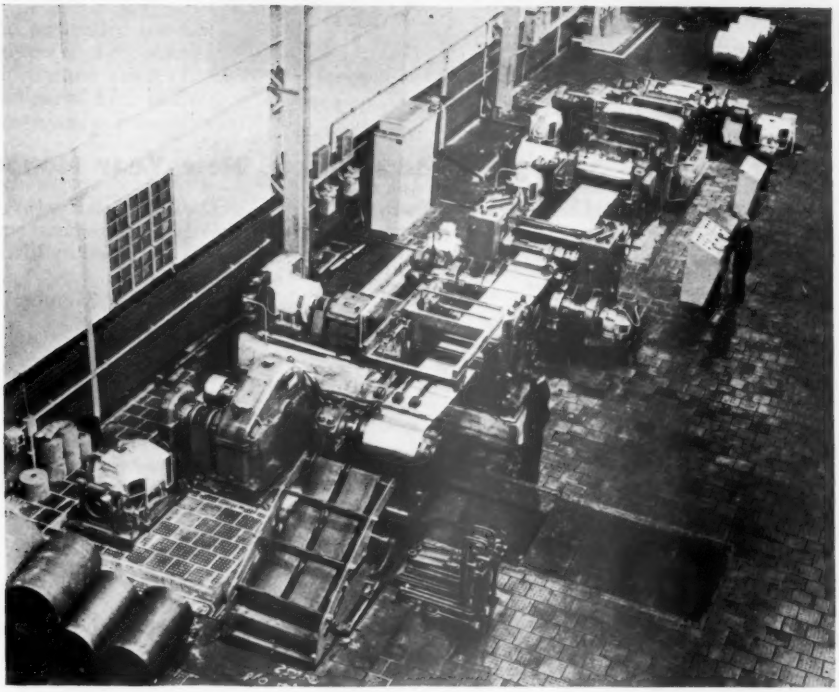


Fig. 21

necessary that both work rolls must be the same diameter.

Fig. 19 shows the ease with which work rolls can be changed. The 4-high mill work rolls roll about 100 tons between grinds, this representing probably about 1,000 tons of through-put, but of course the surface of these rolls, and consequently the surface of the strip, deteriorates progressively throughout this period.

The Sendzimir work rolls will roll about 1–5 ton coil and a new pair of rolls is always used for the last pass, these rolls being then left in the mill to roll the next coil until the last pass. All work rolls are stress relieved in a circulating hot air furnace at 200°C. immediately they are taken from the mill, to prevent surface cracking. The first intermediate rolls will roll about 100 tons or about 1,000 tons of through-put. The second intermediate drive rolls are expected to roll at least 15 times this figure, and we can give no forecast of the life of the roller races, except to state that we have knowledge of races which have been in constant use over two years on three-shift working and show no undue deterioration.

All the races are marked at 6 points as shown in Fig. 20, and after every 100/150 rolling hours it is strongly recommended that the inner race is rotated $\frac{1}{8}$th on its spindle, in order that the wear is evenly distributed. This is rather a big job and as it would result in the mill being out of action for long periods, a complete replacement set of bearing assemblies is always kept in stock, and used in the mill whilst the other set is cleaned and inspected and readjusted.

As solid drums are used in both mills a recoiling line has to be provided in order to take the strip from the drums, and cut off the unrolled ends which result in a reversing mill. (Fig. 21)

You will notice that this line is also used for slitting.

When the line is used for slitting, it can be used with or without back and front tension, and the cutters can either be driven or the strip pulled through.

Cooling and Lubrication of Sendzimir Mill

Operating Instructions.

Circulating Rate—282 Imperial Gallons per minute.
Working capacity of clean and dirty oil tanks—
4000 Imperial Gallons.
Full capacity of clean and dirty oil tanks—
8000 Imperial Gallons.
Oil pressure to bearings—20-30 lb. per sq. inch.
Circulating rate to bearings—
150-175 Imperial Gallons per minute.
Oil pressure to sprays—150 lb. per sq. inch.

Oil from the mill drains by gravity to the heating compartment of the dirty oil tank, where its temperature is raised to 140°F before it passes through coarse wire strainers to the settling compartment.

In the settling compartment are a number of trays

(*concluded on page* 110)

institution notes

Third Annual Aircraft Production Conference, Southampton

The third annual Conference on Aircraft Production, organised by the Southern Section of the Institution, took place at the University of Southampton (by kind permission of the Vice-Chancellor) on 14th and 15th January, 1955.

It is hoped to publish a full report of the proceedings in the March issue of the Journal.

1954 Viscount Nuffield Paper

A full report of the meeting held at the Royal Institution, London, on 9th December, 1954, when the 1954 Viscount Nuffield Paper was presented by Major-General W. A. Lord, C.B., C.B.E., Director of Mechanical Engineering at the War Office, appears on pages 68 to 84 of this Journal.

The Institution was pleased to welcome to this meeting a large number of Service personnel. Among the prominent members of the Institution were two Past Presidents, Sir Cecil Weir, K.C.M.G., K.B.E., D.L., M.C., and Major-General K. C. Appleyard, C.B.E.; the Chairman of Council, Mr. G. R. Pryor; Mr. H. G. Goyns, Vice-President of the South African branch; and Mr. E. C. Gordon England. The President of the Institution, Sir Walter Puckey, presided over the meeting.

New Year Honours

The Institution records with pleasure the following awards made to members in Her Majesty The Queen's New Year Honours List:

Knight Bachelor

H. Spurrier, Member, Managing Director, Leyland Motors, Limited.

C.B.E.

F. W. Halliwell, Member, President, Gauge and Tool Makers' Association, and Chairman and Managing Director, Arnott & Harrison, Ltd.

H. W. Hobbs, Member, Director of Ordnance Factories, Ministry of Supply, Mottingham.

B. A. Williams, O.B.E., Member, Chairman and Managing Director, Williams & Williams, Ltd.

"Working for Better Living" Exhibition

A highly successful Exhibition, with the theme "Working for Better Living," which was held at the Woolwich Polytechnic from 13th/17th December last, owed its inception entirely to the enthusiasm and drive of an Associate Member of the Institution, Mr. L. E. Glover.

Mr. Glover, who teaches management subjects at the Polytechnic, conceived the idea at the Dusseldorf

Major-General W. A. Lord chats with prominent members of the Institution before presenting the 1954 Viscount Nuffield Paper. From left to right are: Mr. H. G. Goyns, Vice-President of the South African branch of the Institution; Mr. G. R. Pryor, Chairman of Council; Major-General K. C. Appleyard, C.B.E., a Past President; Major-General Lord; and the President of the Institution, Sir Walter Puckey.

Exhibition two years ago, and persuaded the British Productivity Council to support the enterprise. Further support was obtained from the Trades Union Congress and the National Industrial Fuel Efficiency Service and seven firms nationally famous also arranged exhibits.

The Exhibition was opened by Sir Thomas Hutton, Director of the British Productivity Council, in the presence of the Mayor of Woolwich, J. W. Andrew, Esq., O.B.E., J.P.

JOURNAL BINDERS

Several members have drawn attention to the fact that owing to the increased size of the Journal during 1954, the binders at present available are not large enough to take the 12 issues.

Larger binders are now on order and should be available shortly. Members who have already received binding cases and found them inadequate are asked to return them to Head Office, when they will be exchanged as soon as possible for the larger size.

"THE AUTOMATIC FACTORY— What does it Mean?"

The Institution's National Conference, Margate, 16th/19th June, 1955.

ONE of the most fascinating themes for a National Conference has been devised by our President for next year's meeting at Margate. The problems connected with the automatic factory contain plenty of food for thought and discussion.

It is important to realise that the true automatic factory contains nothing of which we need be afraid, that is to say, the automatic factory is no new robot but is really a name given to cover the application of science in varying degrees of existing processes. For example, the new petroleum refineries are entirely automatic in operation. This has changed what not so very long ago was process work done on batch production lines to one of continuous flow, where all adjustments are made by automatic equipment so that a continuous output is maintained. There is nothing revolutionary in this, but the important point is the attitude of mind of the engineers who conceived the plant.

The Basic Need

The basic need for an increase in automaticity which may, in some cases, lead to an automatic factory, is that in this country we are living in an age of practically full employment. We still, however, depend on the returns we get from our exports in order to increase our standard of living. Therefore the only way in which we can increase our standard of living is to increase the volume of exports, thus requiring an additional labour force which is non-existent. The only answer is to apply more horsepower to supplement the activities of our labour force. If necessary for a short period we must import the equipment representing this horsepower from abroad. Every time we apply more horsepower to a job we nearly always make the job more automatic, and it is the steady development of the introduction of additional horsepower which leads to the culminating project of an automatic factory.

Conditions of Production

The conditions of production which would require a completely automatic factory are somewhat limited, and would consist of the production of articles at a high rate and of a relatively fixed design. The size of the firm is immaterial. There are many small firms in this country who are to-day maintaining a high volume production of simple articles, brushes for example, and a high degree of automation could be applied to these firms in spite of their small size. On the other hand there are many very large firms whose products are not fixed in design and where the individual rate per product is low. In this case there would be a definite limit to the amount of automation which could be applied in the light of present knowledge. But there is a very crying need, in whatever branch of production we may be engaged, whether on volume or jobbing

production, to examine this problem from the point of view as to whether additional equipment can be applied either to reduce the amount of labour, both direct and indirect, required in the manufacture of an article, or to make more articles with the same volume of labour. The extent to which additional horsepower can be applied is almost entirely dependent on the attitude which production engineers adopt towards their own products.

One of the main objects of the Conference will be to deal not only with the theme of the automatic factory in its broadest sense, but also to examine the problem, in each of the sub-divisions of papers planned, of the application of automatic aids to the small factory and jobbing production, as well as to the large factory and volume production. It is also hoped at the Conference to arrange exhibits of equipment currently available.

News of Members

Mr. A. F. Kelley, Member, General Manager (Manufacturing) of the Aero-Engine Division of Rolls-Royce, Ltd., has been appointed to the Board.

Mr. J. D. Pearson, Member, a Director of Rolls-Royce, Ltd., and Chief Executive of the Aero Division, has been appointed Managing Director, Aero-Engine Division.

Mr. C. H. Swift, Member, has been transferred by his Company, Burton Griffiths & Co. Ltd., from Birmingham, on his appointment to represent the B.S.A. Tools Group in the areas of South Wales and South West England.

Mr. R. N. Stallard, Member, is now General Works Manager of Platt Brothers & Co. Ltd., Oldham, after recently relinquishing his position as Works Manager with Marshall & Sons Limited, Gainsborough.

Mr. J. R. Brooks, Associate Member, has left Wright Brindley & Gell Limited, and has now joined the company of Constructors Limited, Birmingham, as Works Manager.

Mr. G. Nicholson, Associate Member, has recently taken up an appointment as Head of the Engineering Department at the new Poole College of Further Education, Dorset, after being four years as Head of the Engineering Department at the Walker Technical College, Oakengates, Shropshire.

Mr. W. T. Ramsden, Associate Member, has relinquished his position as Development Engineer and Plant Designer with Associated Lead Manufacturers, and is now Works Chief Engineer with Abbott Laboratories Limited, Jarrow-on-Tyne.

Mr. G. W. Reeves, Associate Member, has taken up a new appointment as Engineer III with The Directorate of Inspection of Armaments, Woolwich.

Mr. G. A. Ricketts, Associate Member, has been appointed Overseas Sales Executive for Steels Engineering Products, Ltd., Sunderland, in their Overseas Sales Division, London, and not "Weeks Engineering Products", as stated in the January issue of the Journal.

Mr. H. C. Perry, Associate Member, Production Engineer with the Plessey Company, Ltd., points out that his previous appointment was with Collaro, Ltd., and not "Collars, Ltd.", as stated in the January issue of the Journal.

Mr. R. Ball, Graduate, has taken up an appointment as Works Engineer, with Johnson & Sons, Smelting Works Limited, of Brimsdown, Enfield.

Mr. F. Brodie, Graduate, has relinquished his position as Work Study Engineer with the Pyrene Co. Ltd., Brentford, and has now taken up an appointment as a Senior Work Study Engineer to the Oram-G.E.C. organisation.

Mr. A. Emmerton, Graduate, has left the Buckinghamshire Engineering Co. Ltd., and has joined the English Electric Co. Ltd., Luton, as a Senior Designer.

Mr. J. F. Turgoose, Graduate, has taken up an appointment as Development Engineer, in the Mechanical Engineering Department of The English Electric Company, Luton.

Mr. T. Thompson, Graduate, has now relinquished his position as Work Study Officer with I.C.I. (Metals) Ltd., and has now taken up an appointment with Email Limited of Australia.

PLEASE NOTE

When forwarding particulars of changes of appointment for publication in the Journal, members are particularly asked to supply the information in typewritten form or, if this is not possible, to make sure that all names are written in block letters. This will be of great assistance in ensuring that the information published is accurate.

Hazleton Memorial Library

REVIEWS & ABSTRACTS

Members are asked to note that the Library will normally be open between 10 a.m. and 5.30 p.m. from Monday to Friday each week. It would be helpful if, in addition to the title, the author's name and the classification number could be quoted when ordering books.

Members are reminded that the Library service is available to all members of the Institution and the Librarian is always willing to assist with enquiries.

REVIEWS

"Cold Formed Machine Bolts and Hexagon Nuts." (Case study data on productivity and factory performance. B.L.S. Report No. 47). United States of America—Dept. of Labor—Bureau of Labor Statistics. *Prepared for the Foreign Operations Administration Industrial and Technical Assistance Division by the . . . . . Bureau. London, British Institute of Management*, 1953. 72 *pages*. 5s.

This case study is a first-class example of a careful analysis of the manufacturing methods adopted by a number of companies ranging from the small producer with 300 employees to companies employing over 1,000 hands. A very fair cross-section of the industry is thus examined.

The report is effectively sub-divided into chapters:

Chapter 1. Gives a brief description of the processes involved in the production of cold formed bolts and hexagon nuts. Illustrations are given of the sequence of operation performance when transfer headers are used. This chapter could have been expanded to advantage by giving illustrations of the tooling involved. Many engineers who are not familiar with bolt-makers and nutmakers will have some difficulty in understanding how the variations in form are created.

Chapter 2. This chapter consists of case studies in five different companies and data has been collected under the following headings:—employment, i.e. of direct and indirect workers; volume of production; manufacturing methods; productivity.

The figures given under the above headings in this chapter are very enlightening. A marked difference in indirect labour is recorded in the different factories and considerable variation in machine efficiencies. The methods of manufacture also vary considerably. Some figures on capital investment and tool costs would help in assessing the merits of the different manufacturing methods adopted. Output figures alone tend to be misleading. The illustrations in this chapter are not very clear.

Production Control. At the end of the case studies in Chapter 2 a general report is made on production control methods. A good deal of useful information is given on this subject and also on inventory control. Work-in-progress figures are closely controlled.

Inspection. Methods of inspection are analysed and it is surprising how often micrometers are cited for inspection. Comparators and set-gauges could be used in many instances to advantage.

Chapter 2 is a very interesting collection of data well presented.

Chapter 3. This relates to labour in the fastening industry in the U.S.A. Graphs and tables demonstate how the real hourly earnings of the workers has increased over the years. This makes very interesting reading and makes us realise that we have far to go in this country.

Appendices. There are a number of appendices, but appendix 3 on thread fits is worth of comment. We have reached agreement on unified threads; could we not now have some agreement on methods of inspection?

Our American friends are to be congratulated and thanked for a very fine report.

F.B.W.

(continued overleaf)

NEW BUILDING FUND APPEAL

Since the publication of the last list, donations have been received from the following subscribers. (The list was compiled for press on 25th January, 1955.)

A. G. Clark, M.I.Prod.E.
The Climax Rock Drill Co. Ltd.

F. T. Graham, A.M.I.Prod.E.
L. E. Glover, A.M.I.Prod.E.

Liverpool Graduate Section:-
C. Cameron, Grad.I.Prod.E.
R. O. Jones, Stud.I.Prod.E.

S. Murphy, Grad.I.Prod.E.
K. F. Watson, Grad.I.Prod.E.

S. S. Prakash, A.M.I.Prod.E.
J. & F. Pool Limited.

J. F. Randall, A.M.I.Prod.E.

G. P. Shepherd, Grad.I.Prod.E.

C. E. Taylor, Grad.I.Prod.E.
R H. S. Turner, M.I.Prod.E.

W. O. Vivian, Grad.I.Prod.E.

W. Watson, A.M.I.Prod.E.
J. Weir, Stud.I.Prod.E.
R. Wilson, M.I.Prod.E.

'A History of the Institute of Industrial Administration 1919-1951", by T. G. Rose. *Pitman.* 204 *pages.* 10*s.* 6*d.*

From the title of this book, one would expect that it should have a very limited appeal, but this is not so. Whilst it admirably fulfils the primary purpose of recording the history of the I.I.A., it unfolds a story of the struggles and self-sacrifice of some of the pioneers who have done so much to raise the standards of management in this country.

Written in a style which holds one's interest almost like a novel, by a man who has done so much for management himself, this book deserves reading by everyone interested in men and management.

It tells of the inception of the Institute early in 1919 by Elbourne, Brindley, Comyns Carr and a few other far-sighted business men who realised the urgent need, after the First World War, to improve the standards of management in this country.

Without financial backing and only their confidence and courage to keep up their interest, they prepared educational syllabuses, organised management meetings and set up centres in different parts of the country. With the exception of the band of stalwarts, who with unshakable optimism were determined to carry on, their activities came practically to a standstill in 1923, due to the economic position. They did recover slowly, however, as is now well known, and other than the main problem of finance, the Institution did not have many other difficulties and went on from strength to strength.

In 1946, after twenty-seven years of existence, it must have been a bitter blow to many of the founder members when it was agreed by the Baillieu Committee that £150,000 should be available over a period of five years to set up the British Institute of Management. The right attitude of mind was again clearly demonstrated at one of the Council Meetings, when out of twenty-one opinions which were recorded, not one of them showed anything but a desire to co-operate to the utmost extent, provided always that the standards and background of the I.I.A. as a professional Institute were maintained.

The reviewer would like to repeat that this is not just a book of historical record, but a pointer to the many factors which are missing in industry today.

C.E.

"Factory Health, Safety and Welfare Encyclopaedia", by C. Conway Plumbe, B.Sc. *London, The National Trade Press, Ltd.* 328 *pages.* £1. 10. 0.

The conditions within factories governing safety, health and welfare are vitally important if the industrial status of this country is to be maintained, since the achievements of production are fundamentally founded on such conditions. The book under review is an encyclopaedic reference, serving as a guide to the many problems that occur within a factory. It provides invaluable advice, based on the sound practical knowledge of the Author, whose experience has richly endowed a much-needed reference for the exponents of such work.

Mr Conway Plumbe was for many years in service with the Factory Department of the Ministry of Supply, and he is fully conversant with the administration of the Factories Acts and Regulations. His book provides a comprehensive collection of data, covering 480 separate items, listed alphabetically, with an excellent cross-reference. Names and addresses of various organisations are given in an Appendix, which lists forty-five general items, such as guards, equipment, clothing and instructional films supplied by the 180 firms quoted.

A summary of the three classifications, health, safety and welfare, is given at the commencement of the book, indicating the trends of thought upon which the Author has based his study. A resounding flow of wisdom is prevalent throughout the pages and sound statements are built into each item. These enliven the reading and raise the book to a category above the normal routine guide of information.

Health reactions are considered both psychologically and physically, and it is stated that inadequate lighting, heating and ventilation are often the main cause of minor complaints. Each subject is discussed in detail. For example, lighting is studied under the following headings:—

1. Legal requirements.
2. The case for good lighting.
3. Hazards due to faulty lighting.
4. Personal factors (e.g. the human eye).
5. Common faults in lighting.
6. Sources of illumination.
7. Illumination values.
8. Maintenance and management check.

The physical diseases and poisons constitute a major part of the book, and a guide is given to such complaints as toxic jaundice, silicosis, cancer, cyanide, mercurial, lead, carbon monoxide and other poisons, and the common and irritating disease, dermatitis. Causes, cures and preventatives are outlined in each case.

Accidents give rise to great concern in industry, although greater immunity from risks has been brought about by continuous study and research by various active bodies. "Further work", states the Author, "is needed to educate all concerned on the methods", and a step has been taken in that direction within the pages of this book. The Accident Rate and Statistics are discussed and various references to handbooks and abstracts are quoted. A lengthy explanation of the causes of accidents is given, and a section devoted to the psychological effects, such as "clumsiness, timidity, ignorance, over-confidence and haste".

Machines left unguarded often culminate in serious injuries, and ten pages relate the Factories Acts to this danger. Individual suggestions are made for such items as circular saws and gear-wheels. Space is also given to the inspection of lifting tackle, air receivers and boilers.

The third item, Welfare, gives great scope for imaginative incentive. Only minimum requirements are empowered by the Secretary of State, in compulsory regulations, covering such items as washing and first-aid facilities, protective clothing, meals and supervision of persons employed. Higher standards are sought by progressive firms in colour schemes, social organisations and canteens. Outlines are given for general details of schemes for the initial planning of a canteen, and suggested ideas for management are considered.

The laws governing hours of work are also fully discussed, and explanations of Sunday employment, overtime, shift systems, permissible hours of work, absenteeism, and part-time employment are propounded.

There is very little information that is not included in this industrial "Mrs Beeton's", and the student studying Industrial Administration will find the statistics and definitions exceedingly beneficial. The encyclopaedia is an invaluable guide, not only to the Welfare Officer, but to factory inspectors, Works and Personnel Managers, superintendents and foremen.

A.G.F.

OTHER ADDITIONS

338.98 RELATIONS BETWEEN GOVERNMENT AND INDUSTRY

Administrative Staff College, *Henley-on-Thames.* **"Economic Controls: a Course of Studies Paper."** *Henley-on-Thames, the College,* 1953. 15 *pages.* 2/6d.

Chester, T. E., *and* Smith, J. H. **"Management under Nationalisation: Studies in Decentralisation."** *London, Acton Society Trust,* 1953. 79 *pages.* 7/6d.

518.3 NOMOGRAPHY

Allcock, H. J., *and* Jones, J. Reginald. **"The Nomogram: the Theory and Practical Construction of Computation Charts."** Rev. by J. G. L. Michel. 4th ed. *London, Pitman,* 1950. 238 *pages. Diagrams.*

518.5 SLIDE RULES

Engineer Apprentice. **"Working with the Slide Rule."** *London, Trade and Technical Press Ltd.,* 1954. 40 *pages.* (Issued as supplement to January, 1954, number of *Engineer Apprentice.*)

519.2 STATISTICS; THEORY OR PROBABILITY

Tippett, L. H. C. **"Statistical Methods in Industry"** . . . Six Lectures . . . with an Introductory Lecture by E. S. Pearson. *London, Iron and Steel Industrial Research Council,* 1943. 74 *pages. Charts.*

Yule, G. Udny, *and* Kendall, M. G. **"Introduction to the Theory of Statistics."** 14th ed. revised and enlarged. *London, Griffin,* 1953. 701 *pages. Charts.* £1. 14. 0.

531.7 METROLOGY

Doall Company, *Des Plaines, Ill.* **"Science of Precision Measurement."** Revised ed. *Des Plaines, the Company,* 1953. 264 *pages. Illustrations. Diagrams.* $3.50.

Rolt, F. H. **"Gauges and Fine Measuremnts"** by F. H. Rolt. Ed. by Sir R. T. Glazebrook. *London, Macmillan,* 1929. 2 *vols.*

534.9 ULTRASONICS

Campbell, Norman. **"Select Bibliography of Published References to the Applications of Ultrasonics."** *London, D.S.I.R.,* 1949. 24 *pages.*

539.16 RADIO-ACTIVITY

Great Britain—*Ministry of Labour and National Service—Factory Dept.* **"Precautions in the Use of Ionising Radiations in Industry."** *London, H.M.S.O.,* 1953. 18 *pages.* 2/-.

Shell-Mex and B.P. Ltd., *London.* **"The Atom in Harness: an Account of the Use of Radioactivity for Measuring Wear in Engines."** *London, the Company,* 1953. 20 *pages. Illustrations.*

607 RESEARCH

Institution of Engineers, *Australia.* **"Survey of Australian Engineering Research."** (*Melbourne*), *the Institution,* 1952. 62 *pages.*

614.8 PREVENTION OF ACCIDENTS; SAFETY MEASURES

National Industrial Safety Conference, *Scarborough,* 1952. **"Proceedings."** *London, Royal Society for the Prevention of Accidents* (1952. 99 *pages.* 10/-.

Minton, A. S., *and* Thomas, W., *eds.* **"Hazardous Industries."** Ed. by A. S. Minton *and* W. Thomas. *London, Chantry Publications Ltd. for Institution of Fire Engineers,* 1953. 16 *pages.* 6/-.

621.2 HYDRAULIC SYSTEMS AND MACHINES

Vickers Inc., *Detroit, Mich.* **"Hydraulics for Industrial Machinery."** *Detroit, the Firm* (1953). 16 *pages. Illustrations. Diagrams.*

621.51 PNEUMATIC APPARATUS AND MACHINES

Vacuum Oil Company Ltd., *London.* **"Air Compressor Lubrication."** *London, the Company* 195). 72 *pages. Diagrams.* (Vacuum Technical Series, No. 5.)

621.7 WORKSHOP PRACTICE

Baty, J. E., *ed.* **"British Standards for Workshop Practice."** *London, British Standards Institution,* 1953. 632 *pages. Illustrated.* £1. 1. 0. (B.S. Handbook, No. 2.)

Steeds, W. **"Engineering Materials Machine Tools and Processes."** Second edition. *London, Longmans Green and Co.,* 1952. 345 *pages. Illustrated. Diagrams.* £1. 2. 6.

621.73 FORGING

Great Britain—*Ministry of Labour and National Service—Factory Dept.—Committee on Conditions in the Drop Forging Industry.* **"Report of the Committee."** *London, H.M.S.O.,* 1953. 33 *pages.*

621.74 FOUNDRY WORK

Harborough Construction Co. Ltd., *Market Harborough, Leics.* **"Non-ferrous Melting Practice and Flux Treatment for the Production of Sound Castings."** *Market Harborough, the Company* (1953). 22 *pages.*

Marotta, A. J. **"Shell Molding Process and Magnesium Castings."** *New York, Magnesium Association,* 1952. 8 *pages. Illustrated.*

389.6 STANDARDIZATION

Salmon, P. **"La Normalisation dans quelques aspects de la productivite.** *Pages* 266-269 *of Societe des Ingenieurs Civils de France, Paris, Bulleton No.* 17, 1953.

433 GERMAN DICTIONARIES

Freeman, Henry G. **"Fachworterbuch Werkzeuge. I Teil, Deutsch-Englisch.** *Essen, Girardet,* 1950. 319 *pages.* £2. 5s. 0d.

539.16 RADIO ACTIVITY

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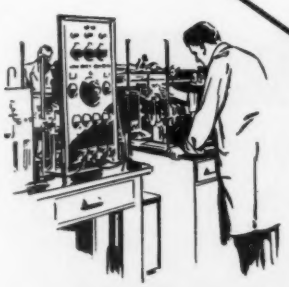

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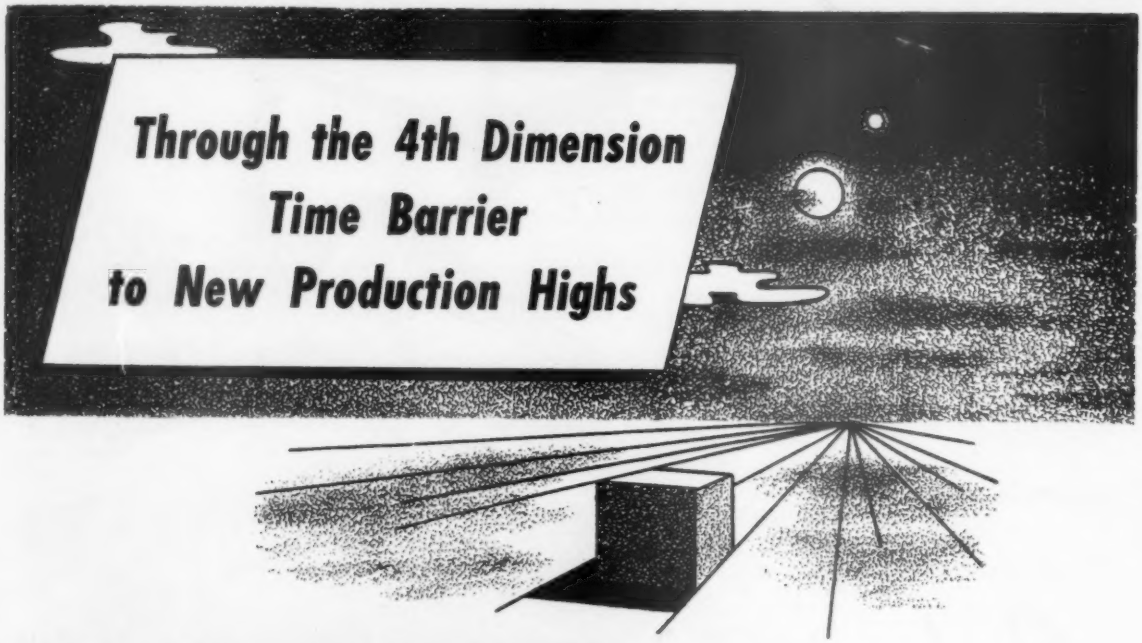

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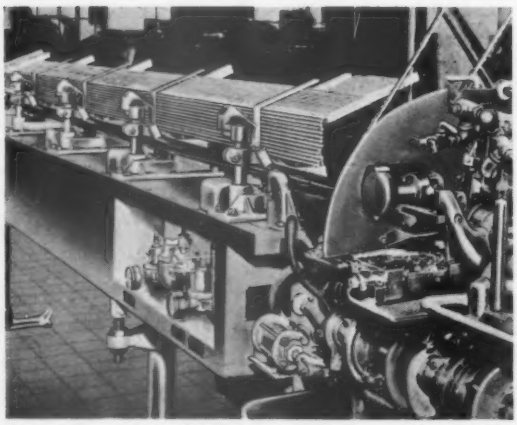

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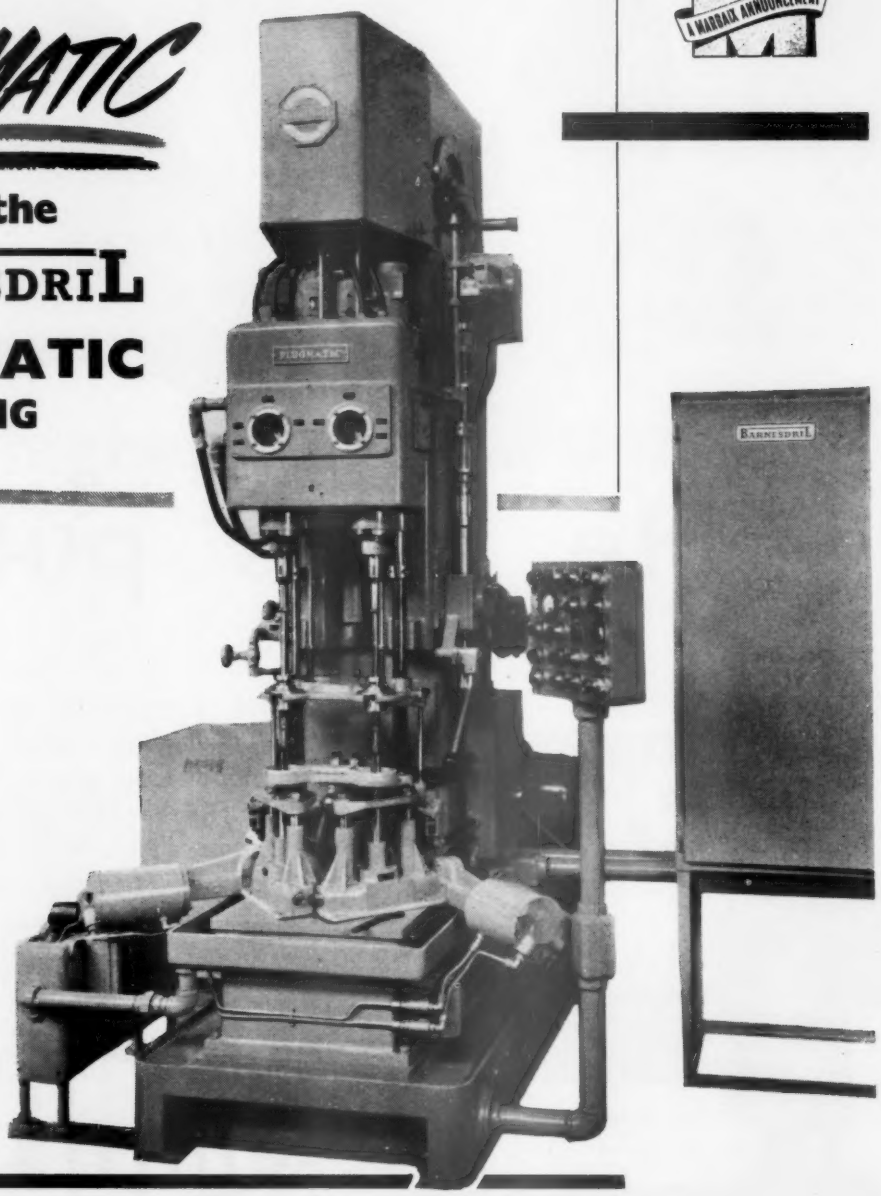

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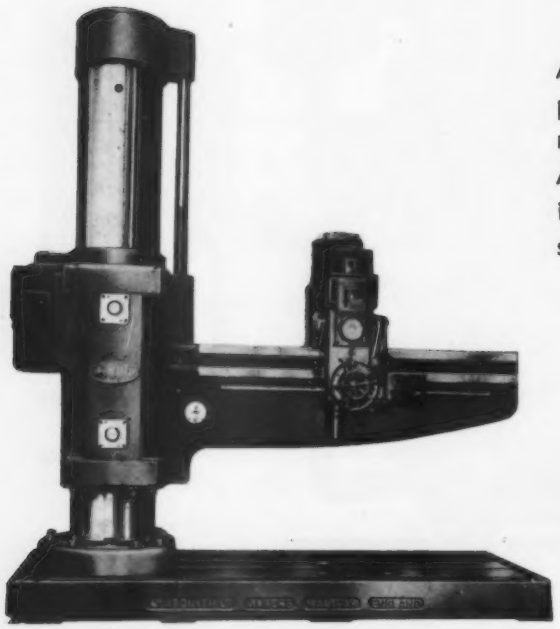

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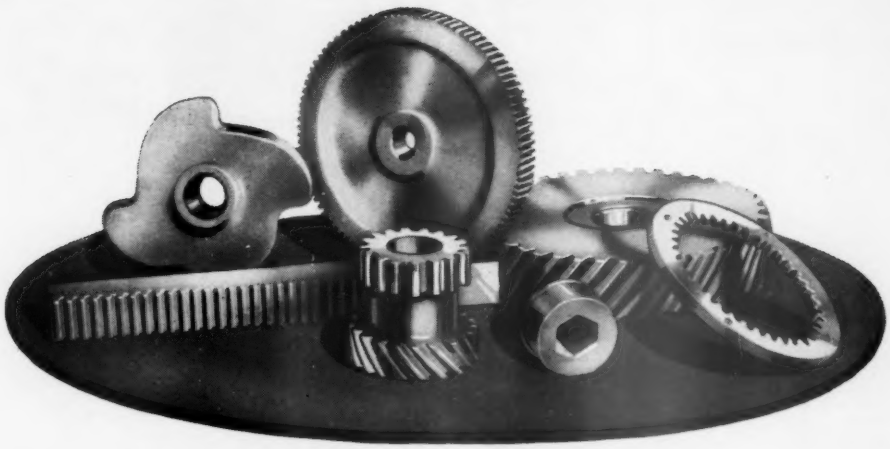

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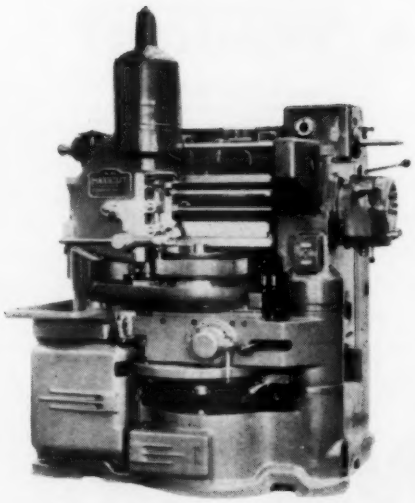

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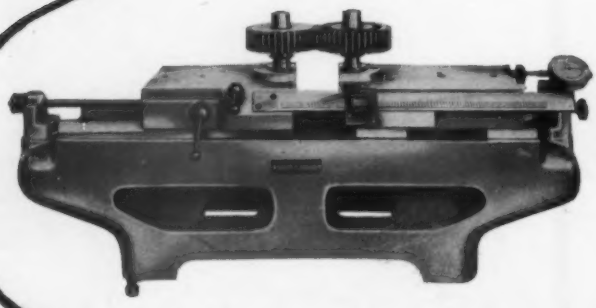

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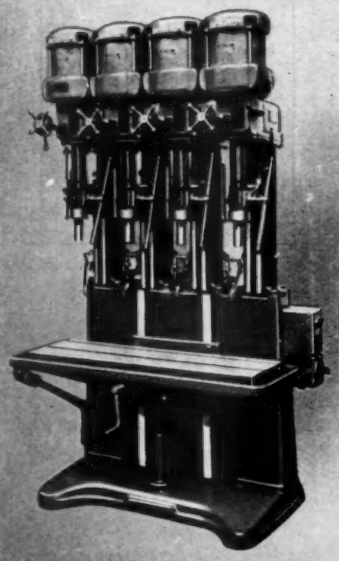

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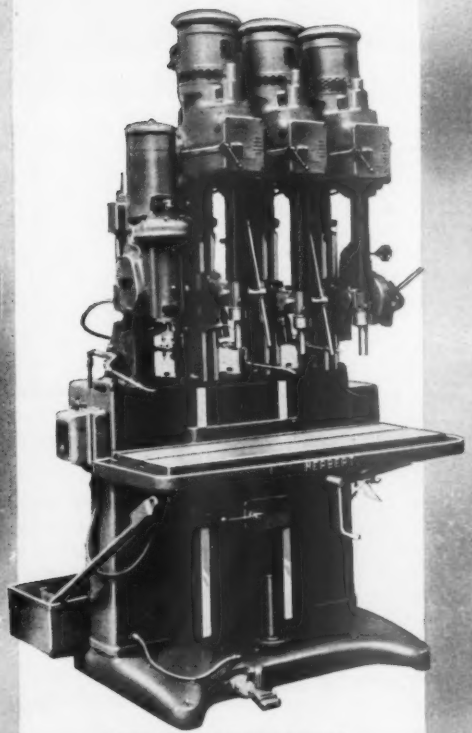

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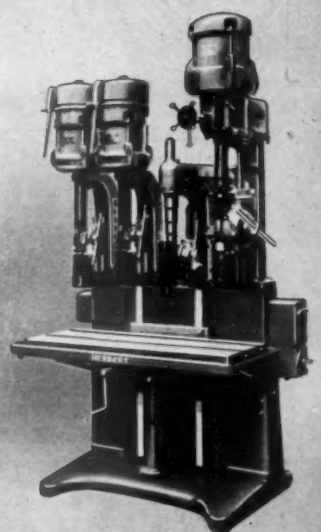

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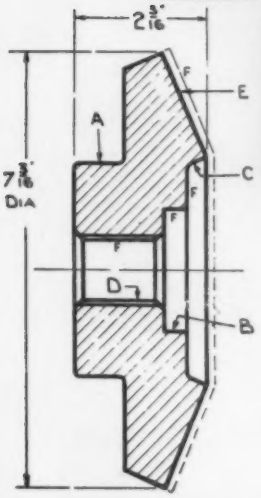


DESCRIPTION OF OPERATION	Tool Position		Spindle Speed R.P.M.	Surface Speed Ft. per Min.	Feed Cuts per inch
	Hex. Turret	Cross-slide			
Chuck on A	—	—	—	—	—
Rough Face End	—	S.T.1	240	260	93
Rough Bore B	1	—	500	260	Hand
Recess Bore C	2	—	240/35	240/35	Hand
Chamfer Bores	3	—	700	690	Hand
Finish Bore B and Bore D	4	—	1000	525	270
Rough Angle Face E	—	S.T.2	240	450	133/Hand
Finish Angle Face E (2 cuts)	5	Rear	240/350	450/650	93/133
Tap 1 1/8" × 14 T.P.I	6	—	70	20	14
Chamfer O/dia	—	S.T.2	70	130	Hand
Remove	—	—	—	—	—

50 Ton Tensile Steel Forging, En.9 Tungsten Carbide Cutting Tools

Floor to Floor Time · 10½ minutes

The Ward No. 7 'Prelector' Combination Turret Lathe has been designed for production from bars up to 2.1/2 in. dia. and chuck work having a maximum swing of 16in. over the bed covers. Special features incorporated in the machine include the patented hydraulic preselecting speed change system which provides for setting the speed for any operation whilst the previous operation is running. Maximum production within the capacity of the lathe is ensured by making full use of Tungsten Carbide cutting tools. The Bevel Wheel Blank illustrated above is a typical example of work produced on the No. 7 'Prelector' Combination Turret Lathe.

OUR EXTENSIVE RANGE INCLUDES CAPSTAN AND TURRET LATHES WITH CAPACITIES UP TO 35 in. SWING OVER THE BED.

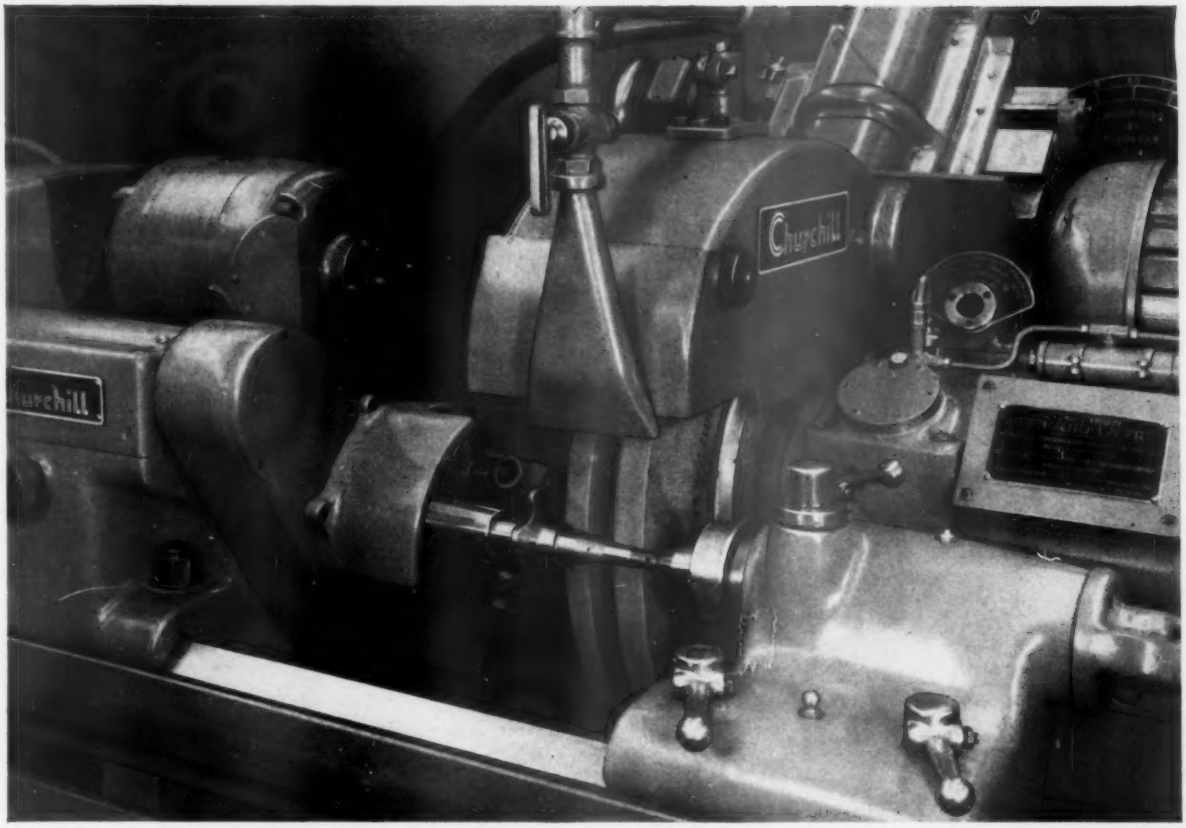
Full details on application.

H.W. WARD & CO. LTD

SELLY OAK BIRMINGHAM 29

TELEPHONE SELLY OAK 1131

W598A



Churchill

The CHURCHILL Model 'BW' 10″ swing Plain Grinding Machine has a reputation for accuracy and high output. The machine shown here is equipped with twin grinding wheels for grinding two diameters simultaneously. The wheel forming device is mounted permanently on the back of the wheelhead and enables the wheels to be trued in correct relationship to the finished work diameters.

The 'BW' Machine can be supplied as a non-automatic or fully automatic Plain Grinder.

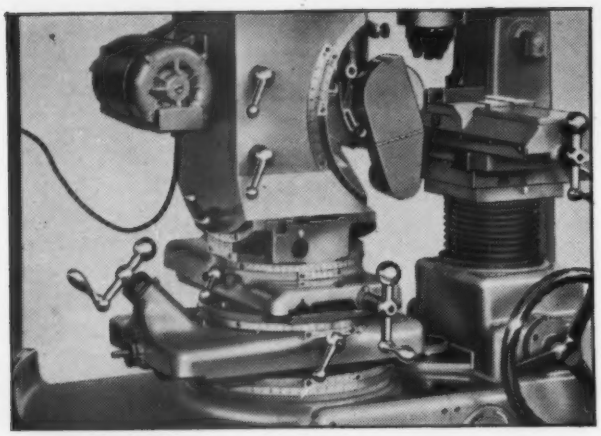
THE CHURCHILL MACHINE TOOL CO. LTD., BROADHEATH, nr. MANCHESTER

Export Sales Organisation: Associated British Machine Tool Makers Ltd., London, Branches and Agents

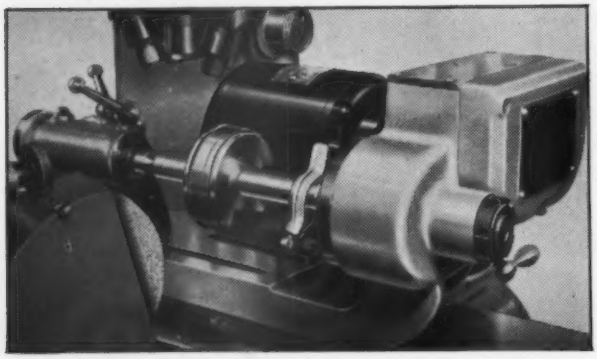
Home Selling Agents: Charles Churchill & Co. Ltd., Birmingham and Branches.

PRECISION *plus* PRODUCTION

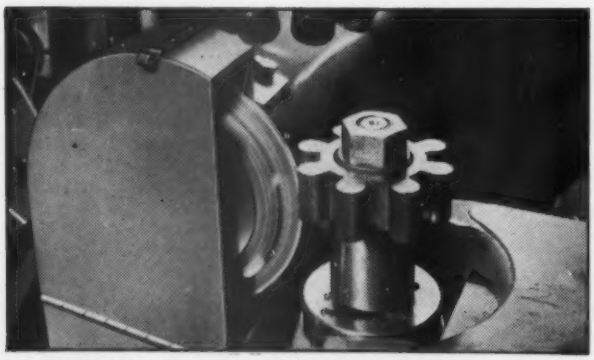
C638B



RELIEF ANGLES.
Front or side relief up to 10° can be produced on cutting tools by a simple setting of the wheel head.



CIRCULAR FORM GRINDING.
For circular form tools and similar work, a circular grinding attachment is available.



INDEXING.
In the production of cams, punches, and dies, the use of the indexing attachment, which can be locked in any of the angular locations provided, is an invaluable aid for the production of all-round forms.

"The most useful

Typical of many such remarks applied to the Wickman Optical Profile Grinding Machine is this considered statement made by a toolroom supervisor recently. And calling to mind some of the complicated and uncertain grinding improvisations that were previously the order of the day, his satisfaction can be understood.

For the production of intricate profiles in hardened steel or tungsten carbide, for gauges, form tools and punches and split dies for press tools, there is no simpler system, nor one which offers such universal application.

The preparation of a pencil drawing of the contour 50 *times larger than the form to be produced is the only preparatory work required.*

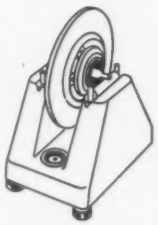
This is applied to the drawing table on the machine and used in conjunction with the pantograph system to trace the required profile.

A microscope is incorporated in the final arm of the pantograph whose path follows the tracing point, outlining the correct profile, the path of the grinding wheel then being traversed by manual control to the cross hair lines of the projection unit.

Accuracy of the work is not affected by wheel wear, and specially shaped wheels are not required.

INTRICATE PROFILES ACCURATELY REPRODUCED.
By the combined use of the compound slides, set to vernier scales, and the pantograph positioned microscope, profiles can be simply and positively produced to limits of accuracy frequently closer than 5/10th of a 'thou'.

WHEEL BALANCING.
Where high accuracy and finish are required, perfectly balanced wheels are essential. Equipment available for this purpose is simple and effective.



Wickman

W I C K M A N

MACHINE TOOL DIVISION, BANNER LANE,

piece of equipment we have"

WICKMAN
OPTICAL PROFILE
GRINDING MACHINE

L I M I T E D

COVENTRY, ENGLAND *Telephone: Tile Hill 66271*

Tungsten carbide
for long tool life
—that means **Wimet**

362 WMG

"I told him straight! . . ."

said the Factory Manager

"*I told the Guv'nor straight*," he said, "*— if you want this lot out on time, I want more up-to-date handling equipment!*"

We murmured admiration for his fearlessness . . . then we told him we were from Yale & Towne; we'd been called in by "the Guv'nor" to see how we could help.

"*Well, you can see for yourself the trouble*," he said, with a sweep of his hand. "*Hold-ups here — hold-ups there. We just can't keep the stuff moving.*"

We checked everything that was moved in, around and out of the factory. Our recommendations went to the Board.

A couple of months later we were back at the factory watching the early runs with the new equipment. Everyone was enthusiastic about the way things were going. They had every reason to be: production hold-ups had become a thing of the past.

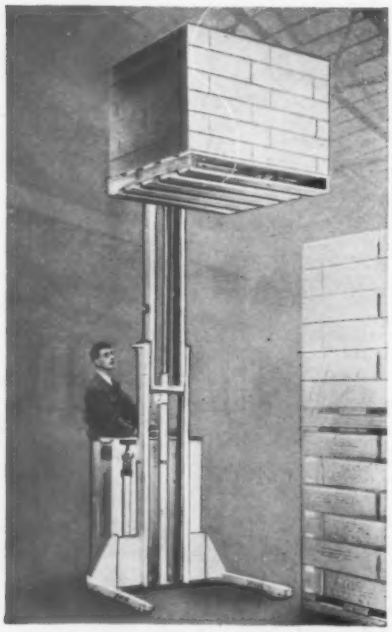
"*The way the Guv'nor's beaming, you'd think it was all his idea*," said the Factory Manager.

Why not pass your handling problems to us? Our Technical Representatives will call and advise you how Yale can solve your materials handling problems and help reduce production costs.

Here's a *new* answer to your "no-space" problem!

The new "Warehouser" range is the latest and most advanced driver-operated series of trucks now available . . . compact, more manœuvrable, fast and safe! The "Warehousers" give you all these outstanding advantages:—

- ★ Rounded rear end for right angle stacking in 5 and 6 foot aisles.
- ★ Lightweight for low floor loadings.
- ★ One hand operation for hoist, lower and drive.
- ★ "Dead man" control — applies brakes, cuts power.
- ★ Safe and easy driving position.
- ★ Fast handling speeds.
- ★ Straddle fork lift models available in 2,000 and 3,000 lbs. capacities, with standard lifts to 147". Pallet and low lift platform models up to 2 tons capacity.
- ★ Available with either lead-acid or nickel-alkaline batteries.
- ★ Low initial cost, low running cost, economical up-keep, long life.



The "Warehouser" Fork-Lift Straddle Truck.

MATERIALS HANDLING EQUIPMENT

MADE IN ENGLAND BY

YALE

REGISTERED TRADE MARK

THE YALE & TOWNE MANUFACTURING COMPANY

MATERIALS HANDLING DIVISION (DEPT. U2) · WEDNESFIELD · STAFFS · PHONE WILLENHALL 630

Archdale

HIGH SPEED MEDIUM DUTY

RADIALS

assure high drilling rates on coal cutter gear boxes at

ANDERSON BOYES & Co., Ltd.
MOTHERWELL

Over 50 holes ranging from $\frac{1}{4}$" to $1\frac{1}{16}$" dia., are drilled and tapped in these cast steel coal cutter gear boxes. Because of their wide speed and feed range, simplicity of control and high penetration rates, ARCHDALE high speed radials assure maximum output on this and many other components in this factory.

SIZES FROM 4 FT. TO 7 FT. RADIUS FOR DRILLING UP TO 3 IN. DIAMETER IN STEEL

JAMES ARCHDALE & CO., LTD. BIRMINGHAM 16 ● SOLE AGENTS: ALFRED HERBERT LTD. COVENTRY

All about Stag Allenite here!

In mass-production, on work of a suitable character, the ideal finish produced by STAG ALLENITE tungsten carbide tipped tools will pay, where machining conditions are good. Made in several grades to suit any application required, Stag Allenite Tools can be supplied in standard shapes, or to customers' own drawings.

For a longer tool life between grinds, remember

STAG ALLENITE

To Edgar Allen and Co., Ltd., Sheffield 9.

Please post 'Allenite' details to:—

Name .....

Firm .....

Address .....

.....

I.P.E.

EDGAR ALLEN & CO·LIMITED
IMPERIAL STEEL WORKS·-SHEFFIELD·9

TELEPHONE: SHEFFIELD 41054. TELEGRAMS: ALLEN, SHEFFIELD 9

KG MACHINE TOOLS

PRECISELY THE MACHINE

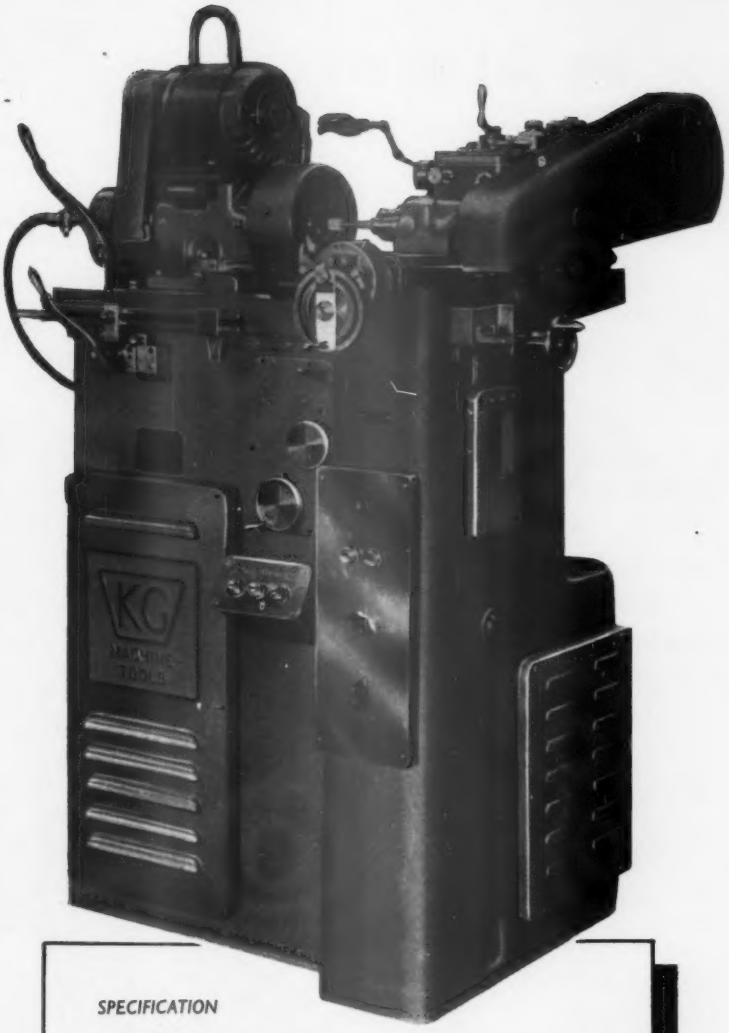
Simplicity in control and ease of operation are the keynotes of the 'KSE' Internal Grinder with the result that high output rates, with close accuracy, can be obtained either in the toolroom or production shop. The absence of complicated controls also ensures that the high output does not fall during the course of a working shift due to operation fatigue.

Hydraulically operated wheelhead feed

6 speed workhead

4 speed gearbox

Pre-set diamond eliminates intermediate gauging



KEIGHLEY MODEL

K S E

SMALL INTERNAL GRINDER

SPECIFICATION

Maximum Diameter Ground (approx.)	1⅝in.
Minimum Diameter, Ground	7/16in.
Maximum Swing inside Guard	4in.
Height of Workhead Centres	4⅜in.
Bore through Workhead Spindle	1 1/16in.
Morse Taper in Spindle	No. 4
Workhead Speeds	365-1,100 r.p.m.
Workhead Swivels	300
Automatic Table Traverse	¼in.-2½in.
Hand Traverse of Table	7½in.
Table Oscillation (Stroke 3ft. min.)	28, 50, 85, 135
Hand Adjustment of Cross-slide	2½
Floor Space required	58in. by 42in.
Weight (approx.)	15 cwts.

A Product of
KEIGHLEY GRINDERS (MT.) LTD., KEIGHLEY, YORKS

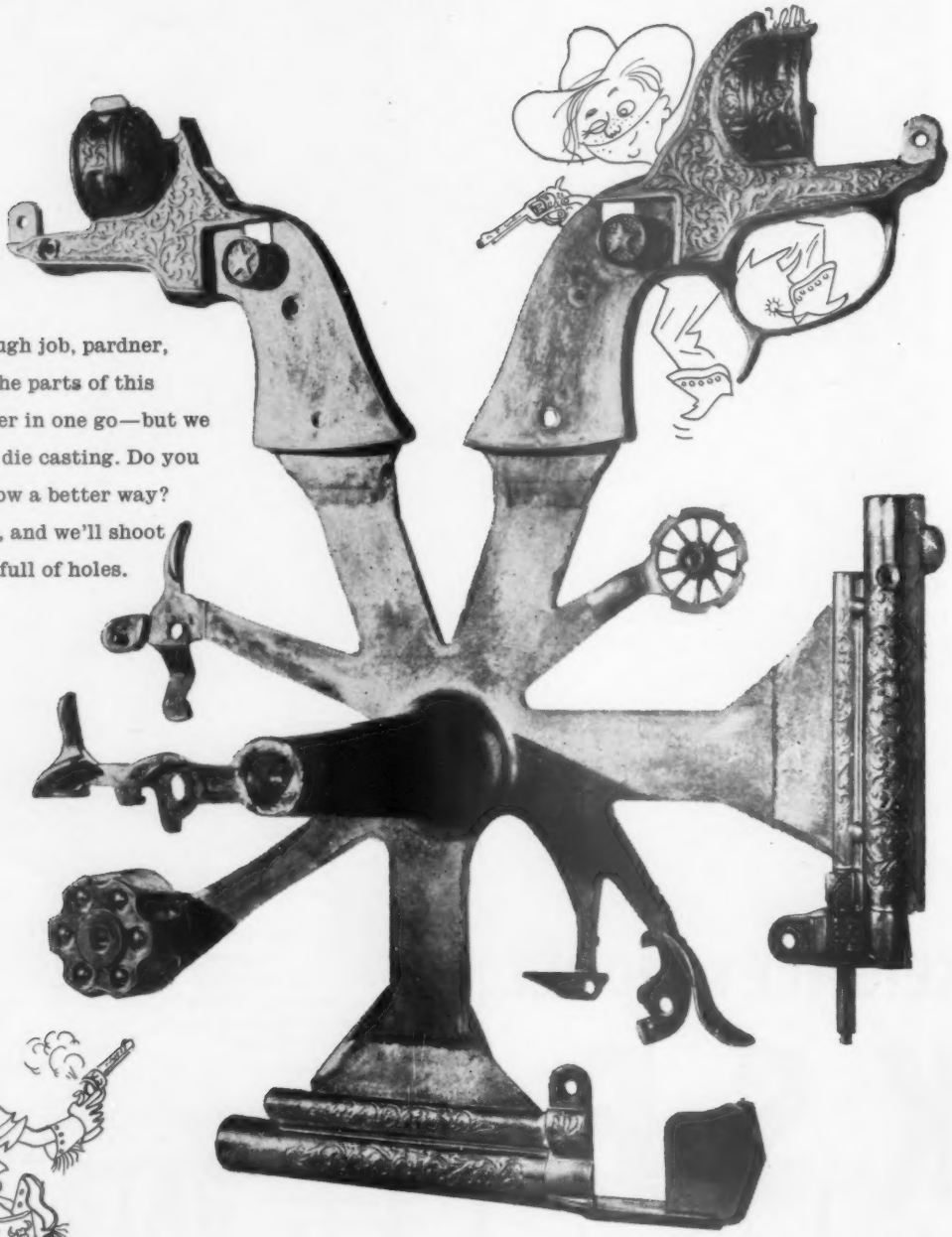
Please address enquiries to—

NEWALL GROUP SALES LIMITED

PETERBOROUGH - Phone Peterborough 3227-8-9 KEIGHLEY - Phone Keighley 4294

Sales Organisation of the
NEWALL GROUP
of
COMPANIES

why pick on us?



A mighty tough job, pardner, to produce all the parts of this li'l ole six-shooter in one go—but we did it, by pressure die casting. Do you think you know a better way? Drop in and see us, and we'll shoot your argument full of holes.

CERTIFIED ZINC ALLOY ZAMCA DIE CASTERS

the whole in one

BRITISH DIE CASTING AND ENGINEERING COMPANY LTD.

EDWARD ROAD · NEW BARNET · HERTS. · TELEPHONE: BARNET 9211

ALSO AT WEST CHIRTON TRADING ESTATE · NORTH SHIELDS · NORTHUMBERLAND · NORTH SHIELDS 2100

CRC 25

ALLOY STEEL BARS

FOR

HIGHLY STRESSED PARTS

BY

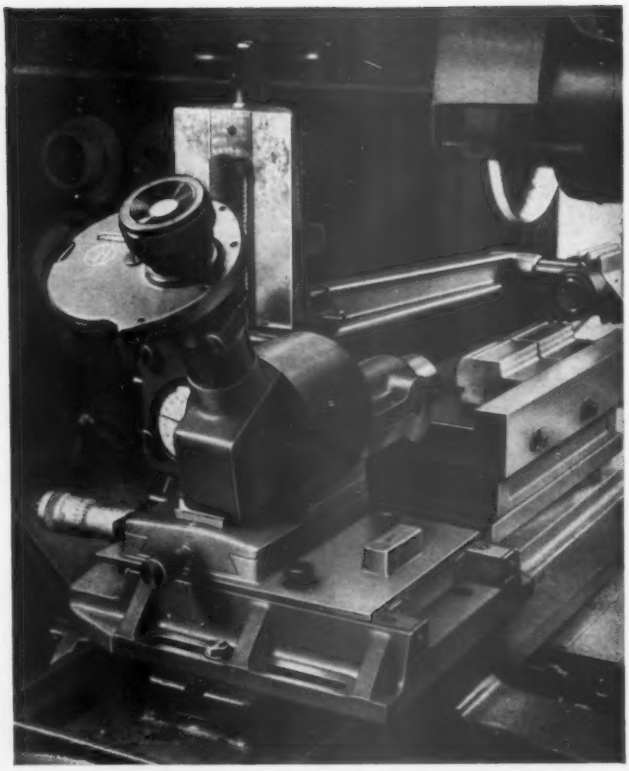
FIRTH BROWN

THOS. FIRTH & JOHN BROWN LIMITED SHEFFIELD

for

INSTANT CONTROL OF ACCURACY ON PROFILE FORMING!

The 'PG' PROFILOSCOPE has proved highly successful for accurately controlling the forming of irregular shapes and profiles during production. It can be simply applied to many types of machine tools and results in tremendous savings in time and greatly increased accuracy. The turret head holds standard and special graticules according to the form to be produced. Magnification 25x or larger.



THE

PROFILOSCOPE

PG LTD

and the PROJECTORSCOPE

This instrument is designed on similar lines to the Profiloscope, but has a screen in place of an eyepiece. The graticule, workpiece or tool, and grinding wheel, are observed at a magnification of 25x on a 7½" dia. screen.

PRECISION GRINDING LTD.

MILL GREEN RD., MITCHAM JUNCTION, SURREY. TEL. MITCHAM 3014

A SUBSIDIARY OF GEORGE H. ALEXANDER MACHINERY LTD. 82-4 COLESHILL ST., B'HAM TEL. ASTON CROSS 3264

SPARKS ARE THE BEST DIESINKERS

Spark machining has shown phenomenal savings in many tool room applications using semi-skilled labour. If your problem is complicated shapes and hard-to-machine materials it would interest you to see our demonstration equipment put to a test on your own particular machining, diesinking or piercing operation.

We illustrate a typical Close Forging Die finished by the Sparcatron Process.

SPARCATRON

TUFFLEY CRESCENT · GLOUCESTER

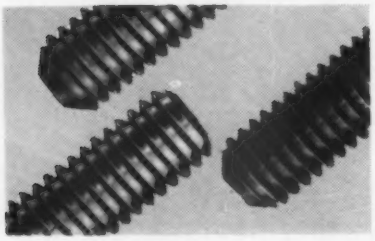
Sparcatron spark machining methods and apparatus are fully protected by British and foreign patents.

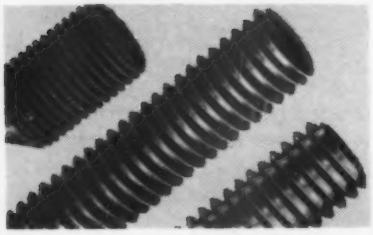
Telephone: Gloucester 21164 (3 Lines)

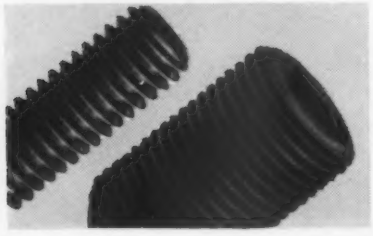
Sole licensees in the United Kingdom: IMPREGNATED DIAMOND PRODUCTS LIMITED · GLOUCESTER

J.W.

Why Unbrako?







To speed production? Look for easy thread start, the hex socket for speedy, sure drive.

For staying power? Unbrako closer tolerances mean a better fit, and their tremendous toughness allows the screws to be pulled up tighter, to stay put longer without locking. Unbrako vibration tests prove this.

For dependability? The reputation of the best equipped specialist screw organisation in Europe stands behind every single Unbrako production, so they've got to be good. They are obtainable all over the world.

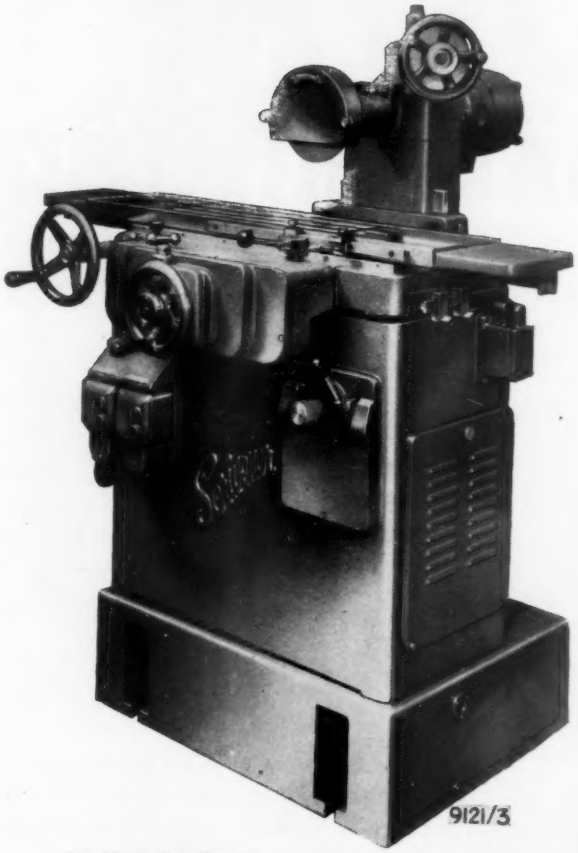
UNBRAKO SCREWS COST LESS THAN TROUBLE

UNBRAKO

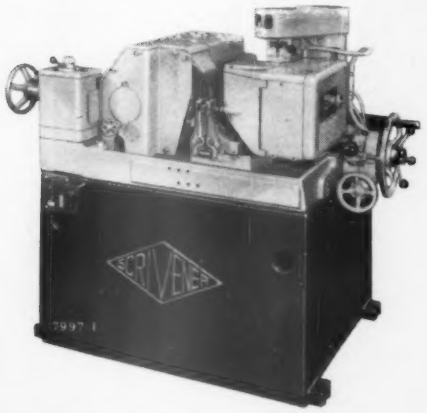
UNBRAKO SOCKET SCREW CO., LTD., COVENTRY

Some Scrivener Grinders

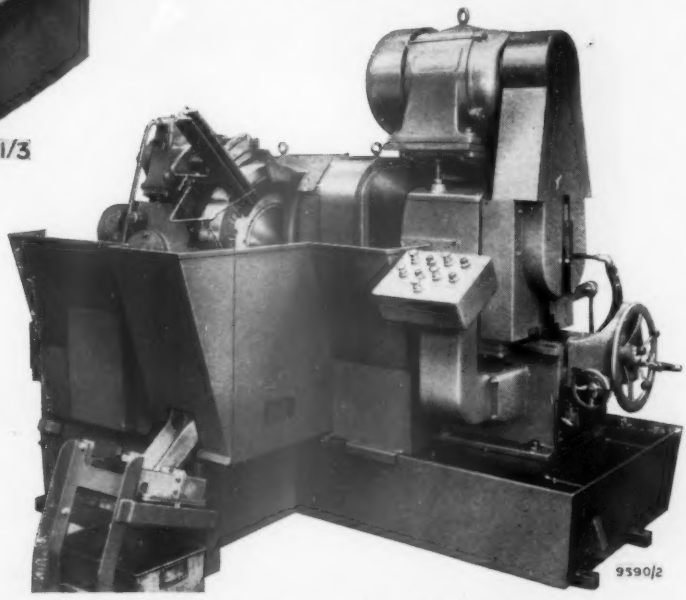
Sole selling agents for Great Britain and Ireland except for last-named: Alfred Herbert Ltd., Coventry



6" x 18" Surface Grinder



No. 1 Centreless Grinder



Automatic Rotary Surface Grinder

SURFACE GRINDERS
(Reciprocating table type)

CENTRELESS GRINDERS

DUPLEX SURFACE GRINDERS

AUTOMATIC HORIZONTAL ROTARY SURFACE GRINDER

Catalogues of any of the foregoing upon application.

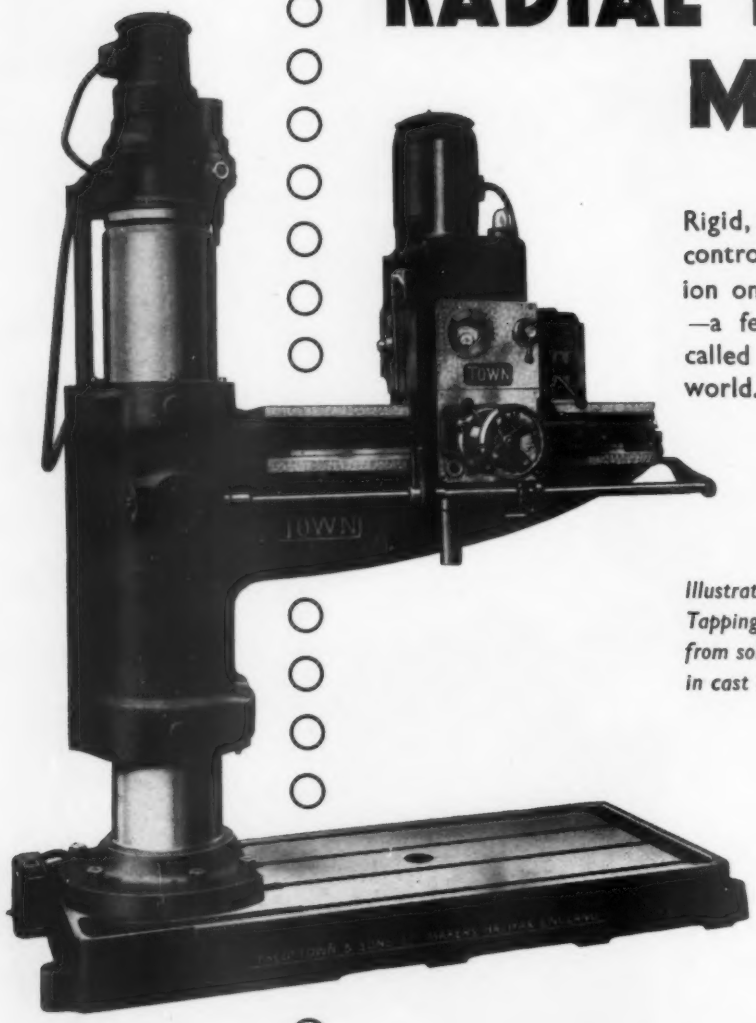
ARTHUR SCRIVENER, LTD. BIRMINGHAM 24

Telephone: ERDington 2274 **Telegrams: "Machint:ol"**

When replying to advertisements please mention the Journal

TOWN

RADIAL DRILLING MACHINES

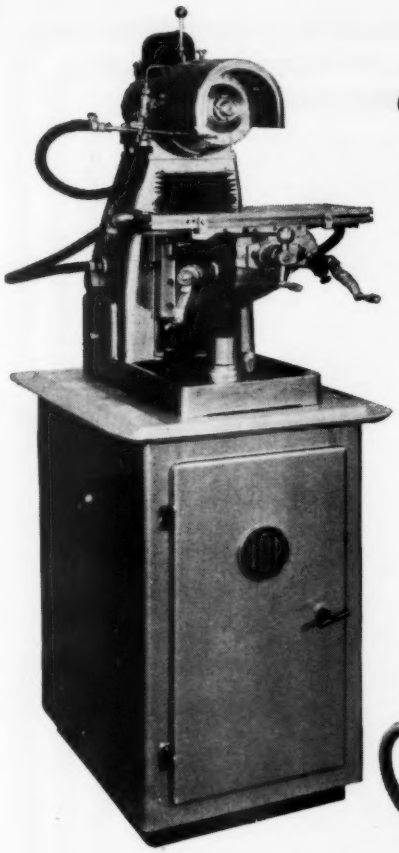


Rigid, simple design, conveniently placed controls and maximum rates of production on the widest range of components —a few of the reasons why they are called upon to give service all over the world.

Illustrated: Town 5ft. A.E.4 Radial Drilling, Boring, Tapping and Studding Machine Drilling capacity from solid 2⅛in. diameter in steel and 3in. diameter in cast iron. Tapping 1¼in. Whitworth.

FREDERICK TOWN & SONS LTD

HALIFAX · YORKS



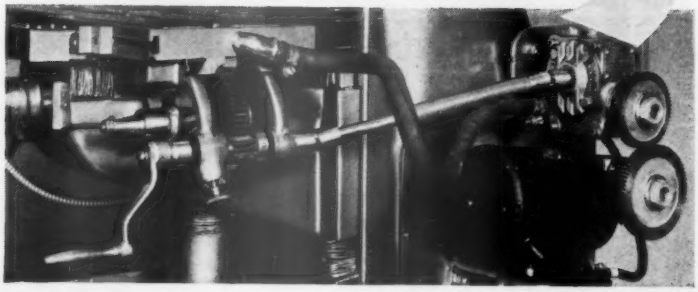
CUTTING AND TOOL GRINDING MACHINE

The G.F.3 was introduced originally to satisfy the demand for a small universal machine suitable for use with Neven Diamond Impregnated Tools for chipbreaker grinding and similar tool room work, and certain production operations.

The Mark II model has been developed on the same lines as the original Mark I, but with many improvements, and also a far higher degree of precision. As a result of numerous requests we have now added to our range the Mark IIa model with an automatic traverse; this retains the original simplicity of the Mark II with the addition of a sturdy and compact traversing unit.

G.F.3 MARK II

G.F.3 MARK IIa with automatic traverse



Close-up of assembly with cover removed

IMPREGNATED DIAMOND PRODUCTS LTD. - GLOUCESTER ENGLAND

TELEPHONE 21164 (3 LINES) TELEGRAMS IMPREG GLOUCESTER

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Having a hand in Productivity

IN EVERY INDUSTRY OR TRADE, electrical equipment is the key to modern production methods. There are probably more production-boosting and money-saving devices than you know of. Your Electricity Board can help you and give you sound advice.

They can also make available to you, on free loan, several films on the uses of electricity in Industry — produced by the Electrical Development Association.

E.D.A. are publishing a series of books on "Electricity and Productivity". Four titles are available at the moment; they deal with Higher Production, Lighting, Materials Handling, and Resistance Heating. The books are 8/6 each (9/- post free) and the Electricity Boards (or E.D.A. themselves) can supply you.

The British Electrical Development Association
2 Savoy Hill, London, W.C.2.

Don't drill a hole

What do you do when you have to measure the plate thickness of a pressure vessel? Drill a hole and hope it is representative? Or do you use modern methods? The man in the picture is using one modern method: he is measuring the plate thickness of a pressure storage tank from one side only. No stunt, this; it is used a lot. It works by ultrasonics. The instrument is portable, as you can see, so there is no difficulty in climbing structures with it. What you cannot see is that the thickness is given by a direct reading on one dial, quickly. Anything from 1/16 in. to 12 in. in steel. This is

only one of the aids to higher productivity that Electricity can bring you.

Electricity a Power of Good for PRODUCTIVITY

Two birds with one stone . . .

The housewife, bless her heart, isn't bothered much about the technicalities of die-casting. She only wants appliances that do their job well. That is why she decides on Acme when she purchases a wringer. Acme, on the other hand, are very much concerned about the quality of the pressure die-casting used in their wringers. Which is why they come to us.

In doing our job, it's pleasant to think how we contribute to domestic bliss, but in truth our main idea is to make production and manufacturing people feel all's well. When it comes to pressure die-castings we do that supremely well. If you have a job in mind that involves pressure die-casting in zinc or aluminium alloys—whether it's a matter of design, quality, quantity or all three, we modestly suggest that a preliminary discussion with us would be to your great advantage.

30 YEARS' ANGLO-AMERICAN DIE-CASTING EXPERIENCE

WOLVERHAMPTON DIE-CASTING
AFFILIATED WITH
PRECISION CASTINGS CO. INC. (U.S.A.)

CERTIFIED ZINC ALLOY ZAMCA DIE CASTERS

THE WOLVERHAMPTON DIE-CASTING COMPANY LIMITED

GRAISELEY HILL WORKS · WOLVERHAMPTON · TELEPHONE 23831/6

In search of THE RIGHT SOLUTION

FOR the efficient cleaning and degreasing of every known metal and alloy there is an "S.A.C." specific. For treatment in circumstances complicated by unusual conditions—the answer can be found by the "S.A.C." technicians. Consultation with "S.A.C." is the shortest, most economical way of finding the right solution for your metal cleaning problems. We have the equipment of today—the experience of many years.

PRODUCTION PROVED PRODUCTS

SUNBEAM ANTI-CORROSIVES LTD.

CENTRAL WORKS · CENTRAL AVENUE · WEST MOLESEY · SURREY

Telephone: Molesey 4484 (5 lines) *Telegrams: Sunanticor, East Molesey*

Manufacturers of

STRIPALENE · FERROCLENE · ALOCLENE · FERROMEDE · BRAZOCLENE

(Regd. Trade Marks)

APPROVED BY ADMIRALTY, WAR OFFICE AND AIR MINISTRY

HOOVER

F.H.P. MOTORS

AUTHORIZED DISTRIBUTORS:

DISTRIBUTOR SERVICE

NATION-WIDE distribution of Hoover F.H.P. Motors exists through the following distributors. Any of them will welcome the opportunity of discussing your requirements.

ANDOVER
Wm. Dibben & Sons Ltd.

BELFAST
Hendron Bros. (Belfast) Ltd.

BIRMINGHAM
The Donovan Electrical Co. Ltd.
E.G.S. Co. Ltd.

BLACKPOOL
Hirst, Ibbetson & Taylor Ltd.

BOSCOMBE
Wm. Dibben & Sons Ltd.

BRADFORD
Herbert Smith (Bradford) Ltd.

BRISTOL
Simpson, Baker & Co. Ltd.

CARDIFF
Simpson, Baker & Co. Ltd
Sound Ltd.

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DUBLIN
Hendron Bros. (Electrical) Ltd.

EXETER
Simpson, Baker & Co. Ltd.

FARNHAM
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GLASGOW
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GUILDFORD
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HULL
E.G.S. Co. Ltd.

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LEEDS
E.G.S. Co. Ltd.
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LIVERPOOL
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British Rawhide Belting Co. Ltd., W.1.
Jeary Electrical Co. Ltd., E.C.1.
G. E. Jones & Sons Ltd., E.10.
H.R.P., Ltd., S.W.3.
Refrigeration Spares Ltd., E.11 and E.C.1.
Rocke International Ltd., S.E.1.
Simpson, Baker & Co. Ltd., S.W.1.
Sun Electrical Co. Ltd., W.C.2.
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LUTON
Alliance Wholesale Ltd.

MAIDSTONE
Alliance Wholesale Ltd.

MANCHESTER
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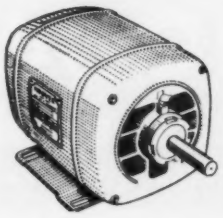

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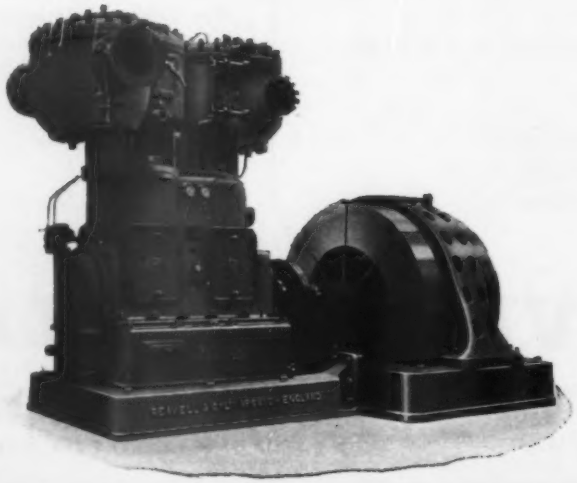

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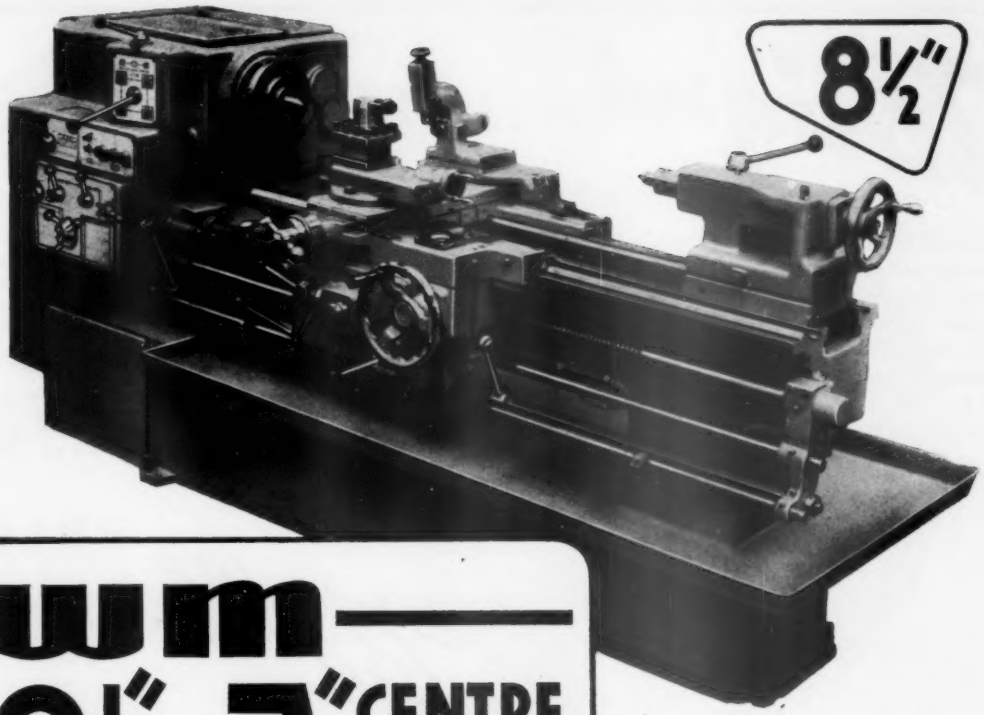

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Above: the WM. "85" 8½ in. S.S. and Sc. Lathe with 8 ft. bed to admit 48 in.

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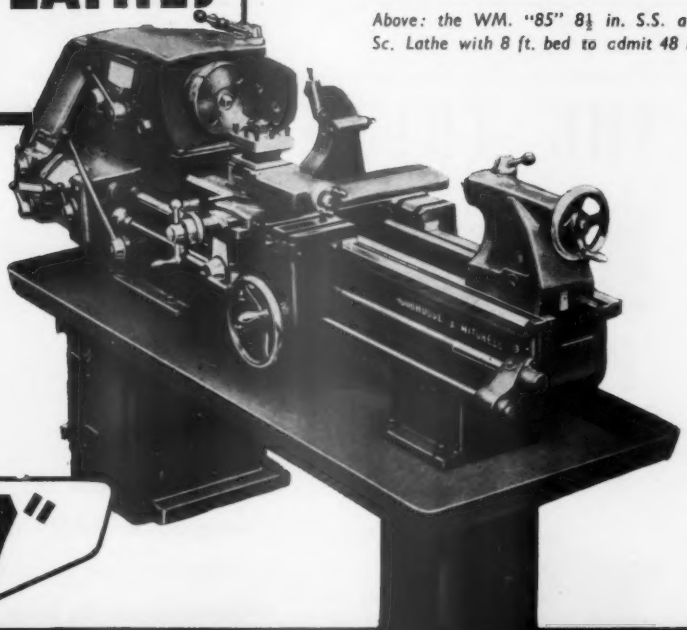

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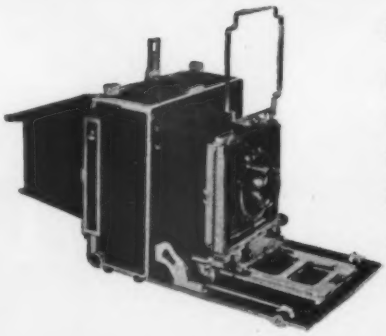

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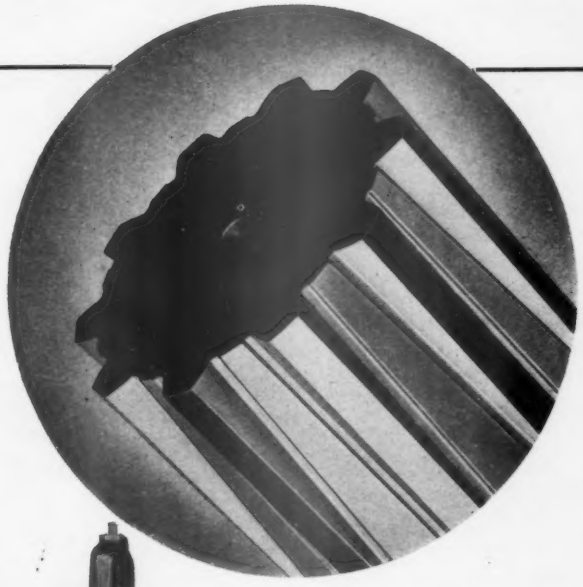

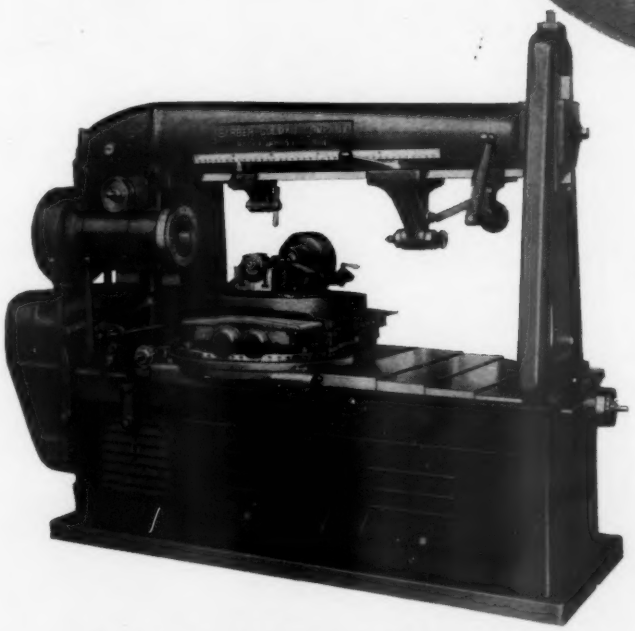

B-C MODEL 16-11 HOBBING MACHINE
Although designed primarily for hobbing taper splines on shafts, this machine may also be used for general purpose hobbing.
It is the ideal machine for the manufacturer who desires to improve his product by applying taper splines, eliminating the necessity of buying a special machine which could otherwise not be used for general work.

Involute or straight-sided TAPER CORE keys for

- Greater strength.
- Metal-to-Metal contact.
- Accurate location of Mating parts.
- Greatest security under reciprocating stresses.
- Provides greater area of key contact.
- Saves time and work in assembling a product.
- Eliminates chance key failure.
- Mating parts produced simply by broaching a tapered reamed hole.

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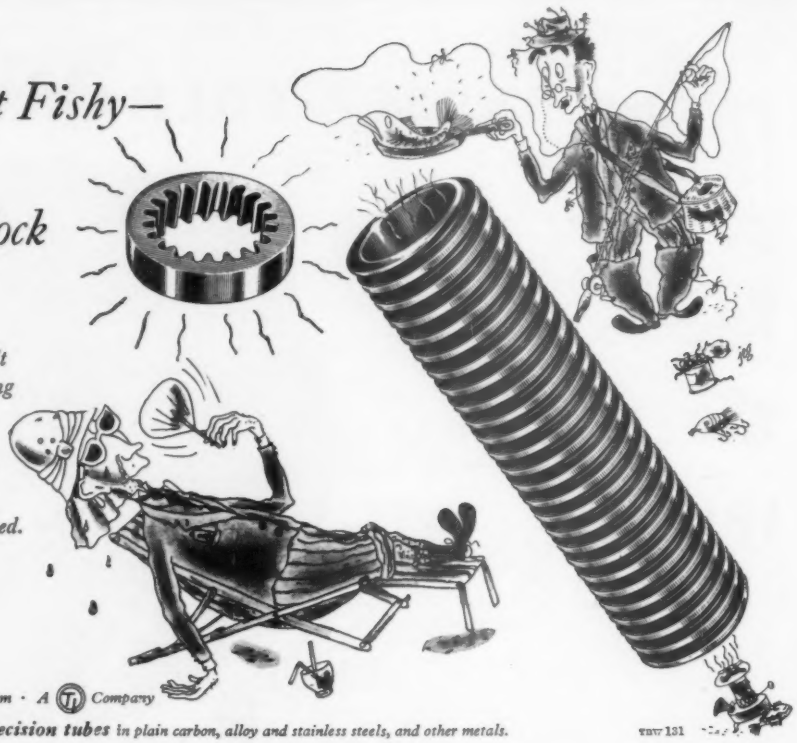

These finned tubes are the result of something new in tube making technique. They are likely to be of interest to those engaged in heat exchanger and similar work, and enquiries from potential users are welcomed.

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Makers and manipulators of precision tubes *in plain carbon, alloy and stainless steels, and other metals.*

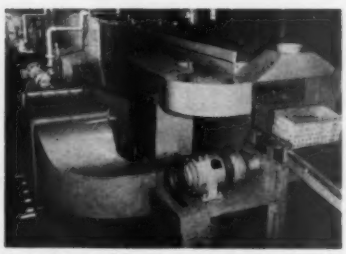
TMW 131

Bratby

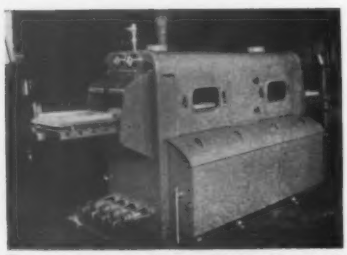
HERE ARE THREE EXAMPLES

INDUSTRIAL CLEANING MACHINES *can be designed to meet your particular cleaning problems*

This illustration shows a machine cleaning crank cases in the production line. It is equally capable of cleaning small parts in baskets.



A power driven conveyor system is employed with this cleaning machine for ball bearings.



Trays carrying the work are pushed through on a roller conveyor by hand in this cleaning installation.

Whilst offering a very wide variety of standard cleaning equipment, it is BRATBY policy, wherever possible to design the machine to meet the particular cleaning problem. Careful study of each individual problem ensures maximum efficiency and economy of the plant in operation. The illustrations show but a few of the specific types of Cleaning Machines designed by BRATBY for individual needs.

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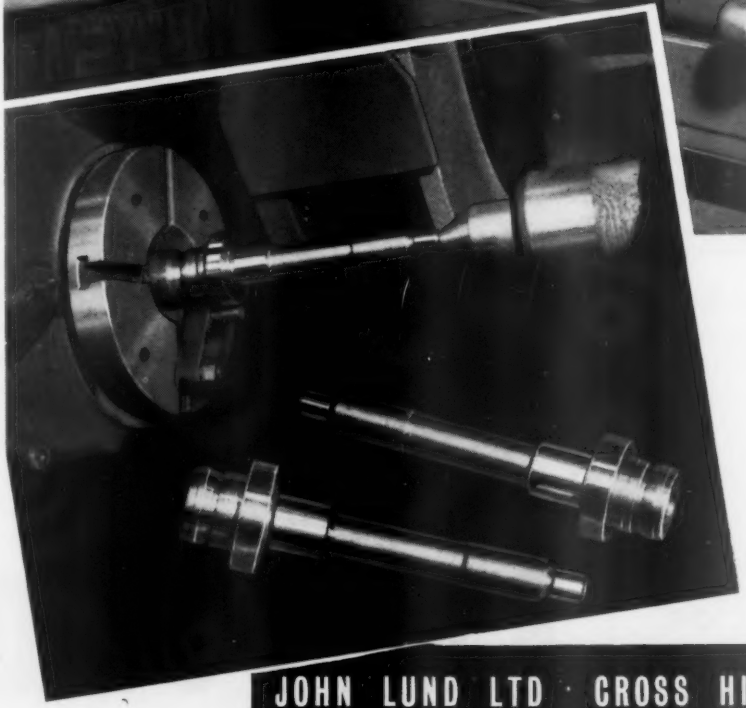
The PRECIMAX Way

AT VAUXHALL MOTORS LTD.



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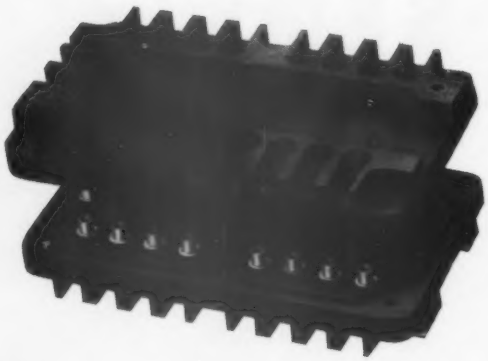

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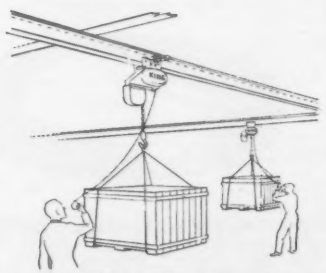
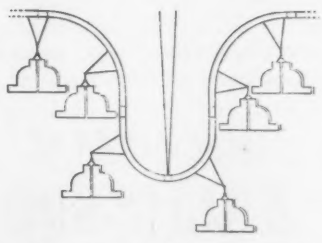


A KING *Marvex Electric Pulley Block and runway*



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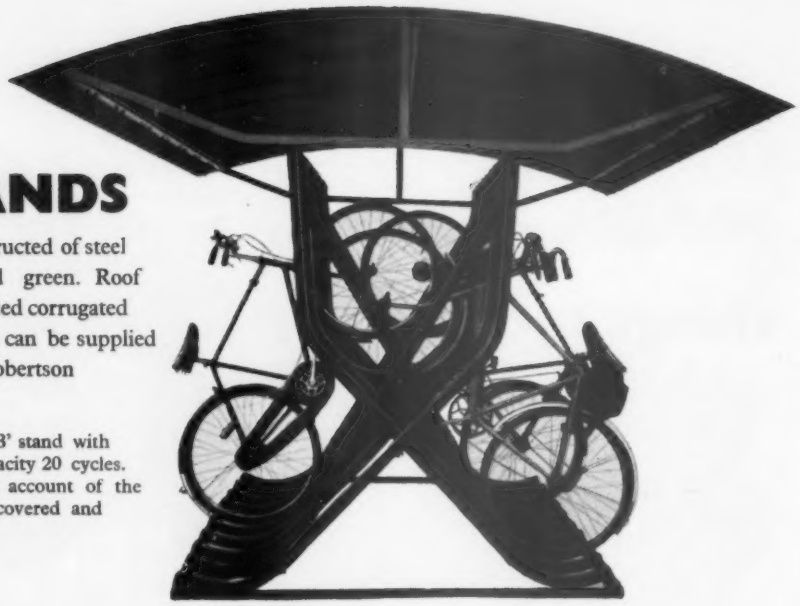
CYCLE STANDS



ABIX Cycle Stands are constructed of steel throughout, stove enamelled green. Roof sheeting is normally of galvanised corrugated sheets. If required, sheeting can be supplied in Aluminium, Asbestos or Robertson Protected Metal.

The illustration is of our Type 'B' stand with 12 inch centres, 10 feet long, capacity 20 cycles. This type of stand is popular on account of the small amount of ground space covered and the generous roof cover.

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Special Cutters—router cutters supplied to customers' requirements.

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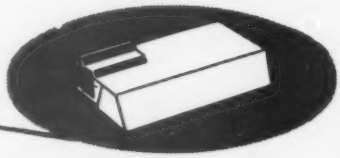

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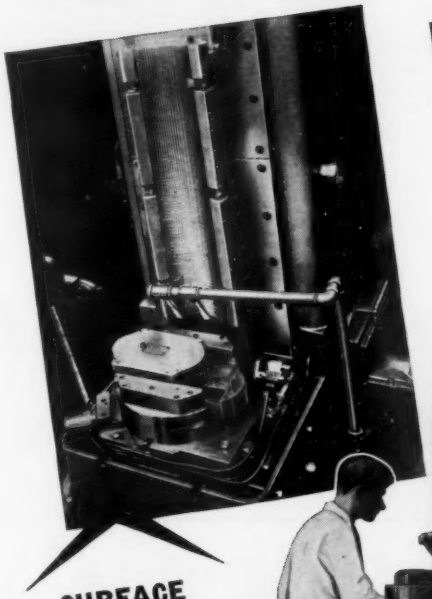

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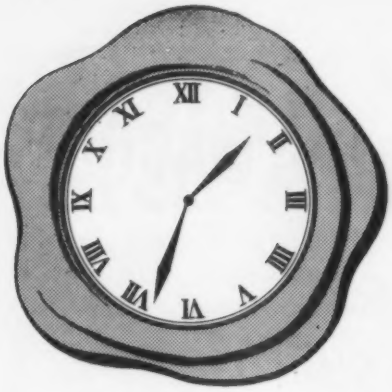

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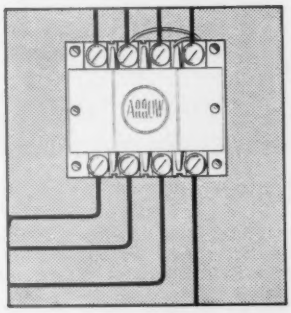

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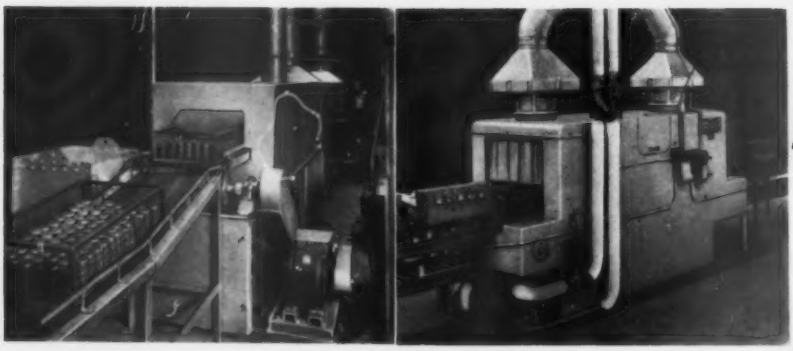

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A 'Junior' type machine supplied to a Midlands Motor Car Works.

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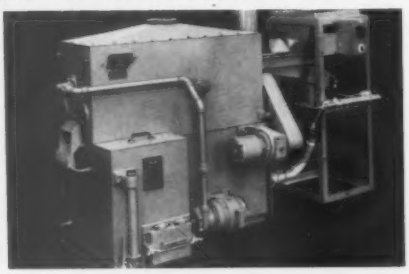
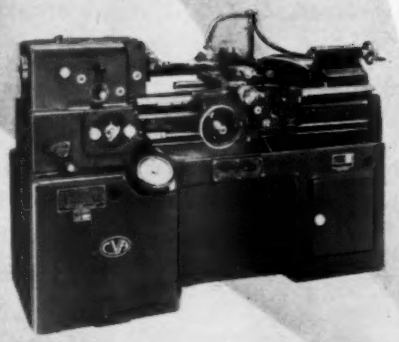
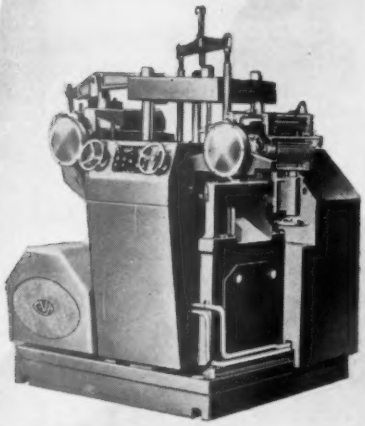


CVA *Machine Tools*





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Four examples are illustrated here, from the extremely wide range distributed by the E. H. J. organisation.

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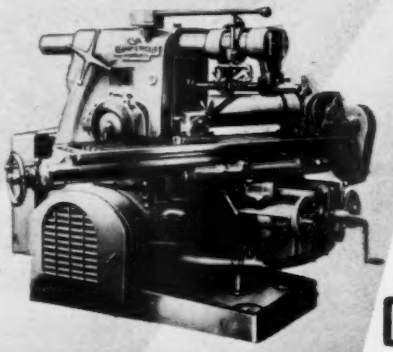

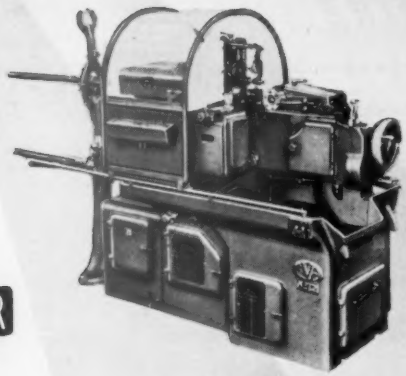

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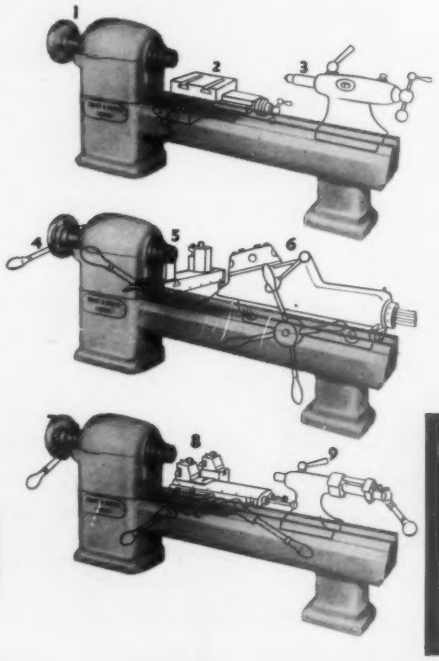

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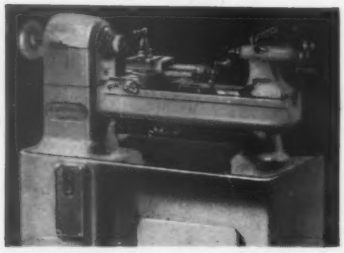

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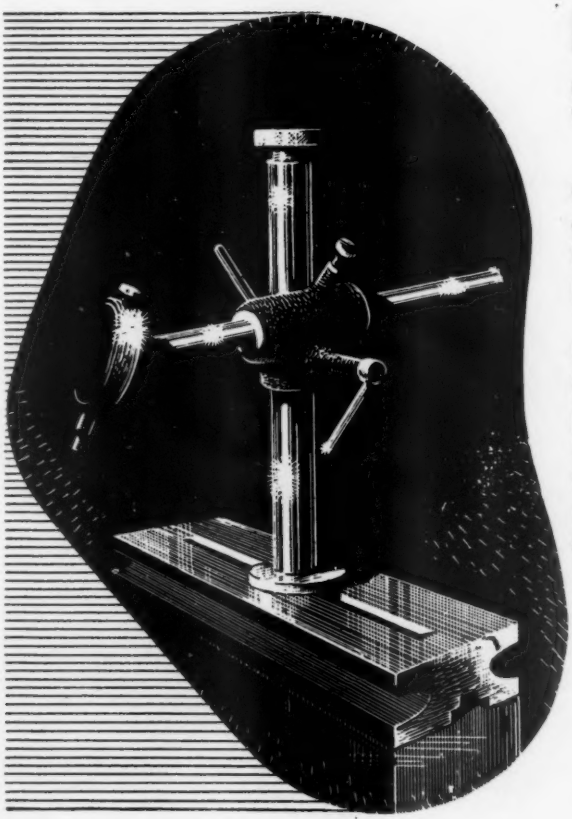

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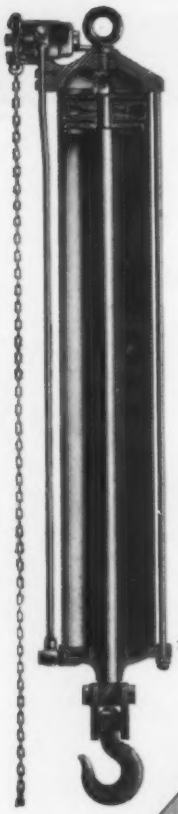

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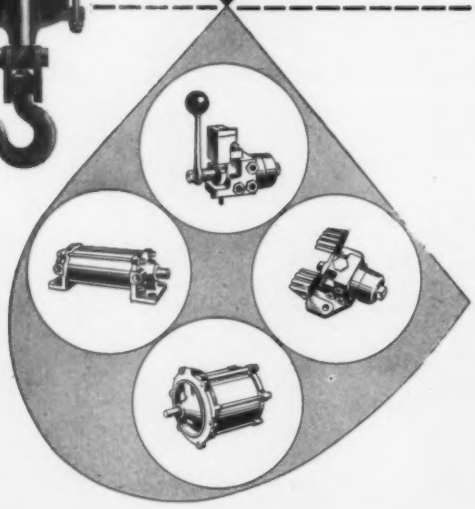

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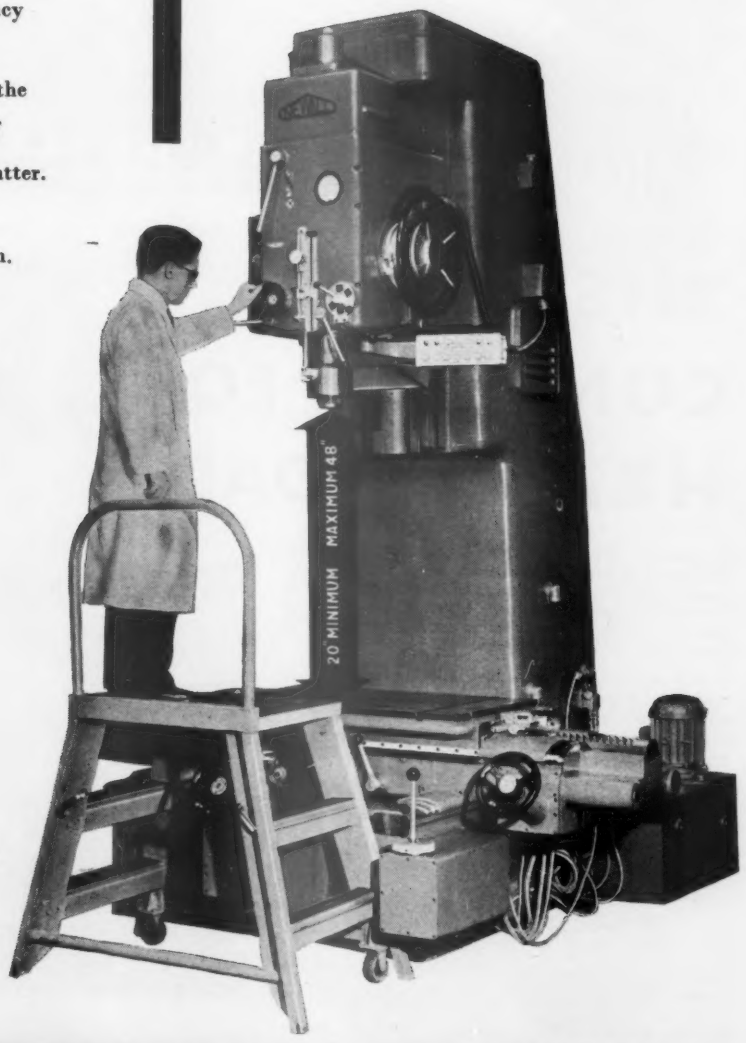

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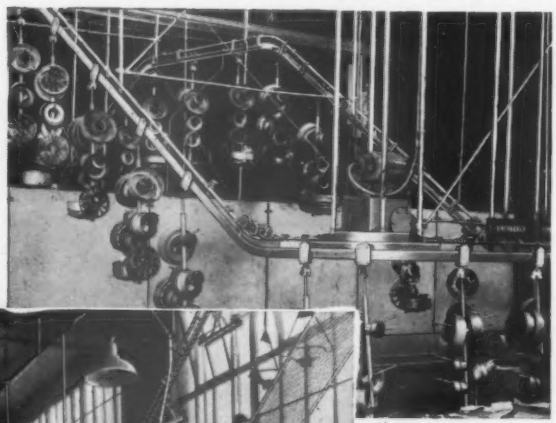
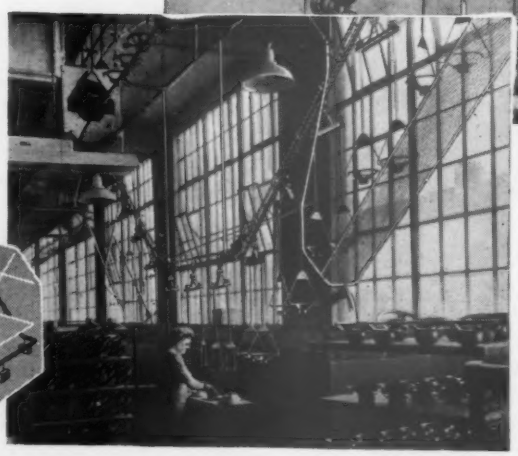
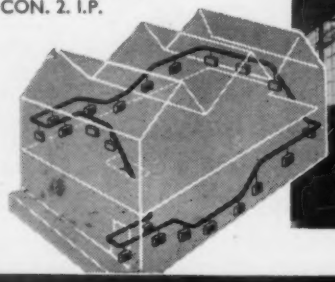




Above:
Teleflex conveyors form an important aspect of the production system of Messrs. A. C. De'co—Division of General Motors.

Left:
Teleflex conveyors are important links in the production lines at the works of the Plessey Co. Ltd., Ilford.



Right: An example of a Teleflex Conveyor which travels all round a particular factory.

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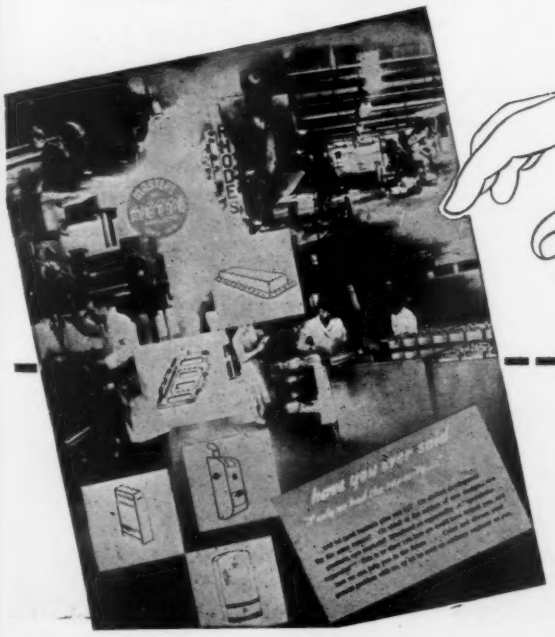

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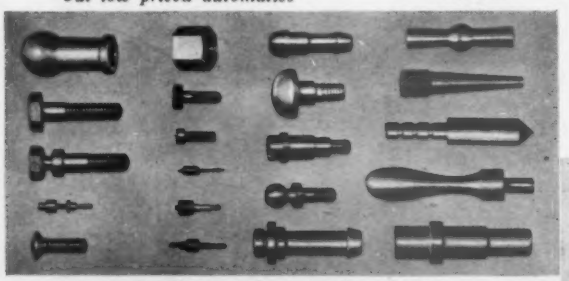

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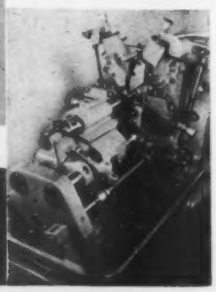

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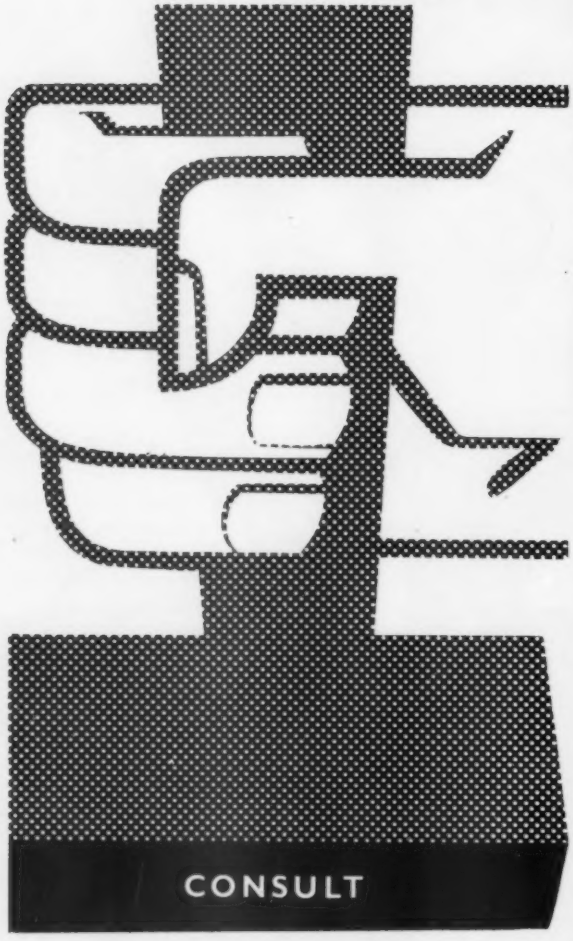

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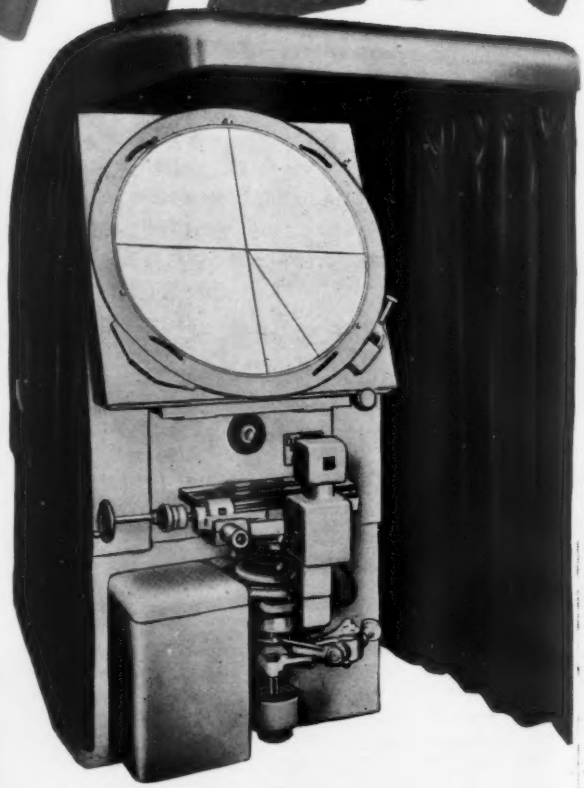

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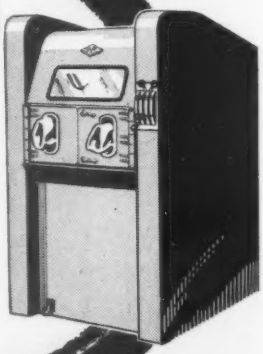

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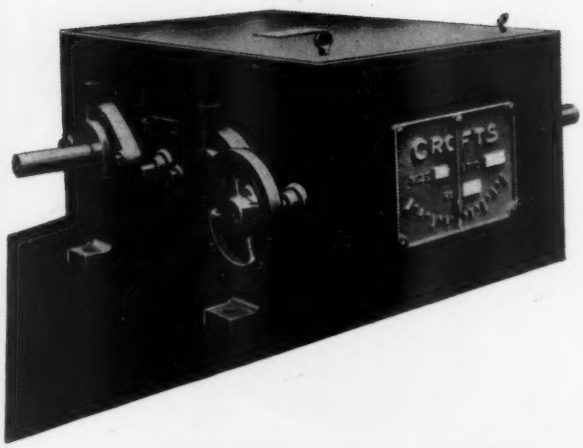

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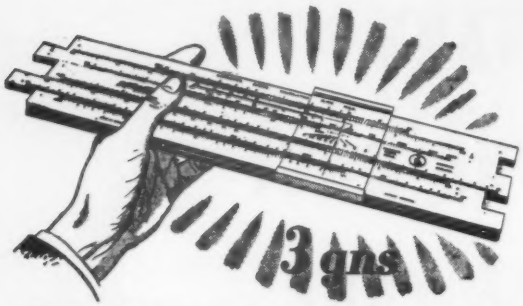

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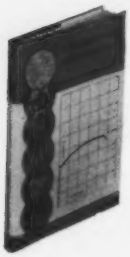

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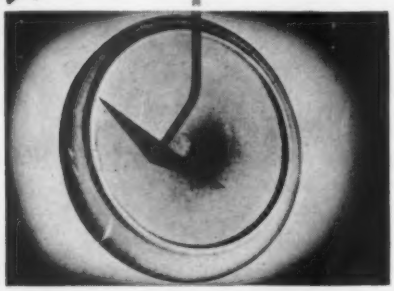

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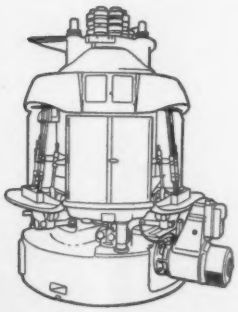

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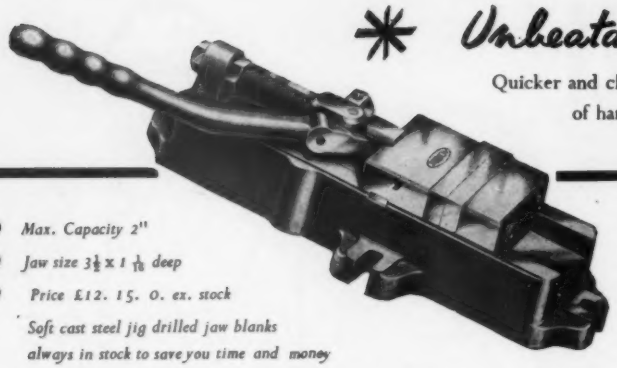

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IN

Vol. 34, No. 2
FEBRUARY, 1955

JOURNAL SUPPLEMENT

INSTITUTION OF PRODUCTION ENGINEERS, 10, CHESTERFIELD ST., LONDON, W.1

A CONFERENCE ON
"COMPRESSED AIR AS AN AID TO PRODUCTIVITY"

has been arranged by the

CORNWALL SECTION OF THE INSTITUTION

to take place at the

CORNWALL TECHNICAL COLLEGE, TREVENSON, CAMBORNE

13th/14th APRIL, 1955

The Conference will be opened by the President of the Institution, Sir Walter Puckey, and the programme will include the following lectures:

1. "Compressed Air and Its Compression," by J. R. Quertier, B.Sc., A.C.G.I., A.F.R.Ae.S., Hon. Technical Director, British Compressed Air Society.
2. "Air Operated Tools," by F. B. Coombes, A.M.I.Prod.E., Chief Designer, Holman Bros., Ltd.
3. "Air Operated Equipment," by W. G. Bennett, B.Sc., M.I.Prod.E., Manager, Climax Rock Drill & Engineering Co., Ltd.
4. "A User's Experience," by W. E. Wright, Chief Planning Engineer, Engine Production Factory, Bristol Aeroplane Co., Ltd.

A number of works visits and demonstrations of pneumatic equipment have also been arranged.

The Conference Fee is 25s. for members of the Institution, and 30s. for non-members. Full details of the programme and application forms may be obtained from the Hon. Secretary of the Cornwall Section, Mr. F. G. Hawke, 17, Church Road, Pool, Redruth, Cornwall, or the Secretary of the Institution, at 10, Chesterfield Street, London, W.1.

MEETINGS

Visitors tickets may be obtained from Section Honorary Secretaries

FEBRUARY, 1955

BIRMINGHAM **FEBRUARY 12th**
The Botanical Gardens, Edgbaston, Birmingham.
Buffet Dance.

BIRMINGHAM **7.0 p.m. FEBRUARY 16th**
The James Watt Memorial Institute, Great Charles Street, Birmingham 3.
"The Skilled Man in Industry," by J. T. Bolas, M.B.E., J.P.

BIRMINGHAM GRADUATE 7.0 p.m. FEBRUARY 8th
The James Watt Memorial Institute, Great Charles Street, Birmingham 3.
"The Work Study Approach in Process and Product Study," by N. A. Dudley, B.Sc., M.I.Prod.E.

BIRMINGHAM GRADUATE 7.0 p.m. FEBRUARY 11th
Works Visit to British Timken Ltd.

COVENTRY **7.0 p.m. FEBRUARY 8th**
The Craven Arms, High Street, Coventry.
"The Production of Precision Involute Gears," by W. T. H. Golding, A.M.I.Prod.E.

COVENTRY GRADUATE 7.15 p.m. FEBRUARY 14th
The Hare and Squirrel Hotel, Cow Lane, Coventry.
A Graduate Discussion on "How Would You Do It?" (Problems of common interest to Production Engineers). Chairman: W. G. Key, G.I.Mech.E., Grad.I.Prod.E., A.M.I.Prod.E.

CORNWALL **7.15 p.m. FEBRUARY 2nd**
The Camborne School of Mines, Camborne.
" British Clock and Watch Production " and Sound Films, by A. W. Marshall, F.B.H.I.

DERBY **7.0 p.m. FEBRUARY 14th**
College of Art, Green Lane, Derby.
" Packaging " by E. H. Dickens, M.B.E.

DONCASTER **7.0 p.m. FEBRUARY 8th**
The Danum Hotel, Doncaster.
" The Manufacture of Plate Glass," by Dr. W. L. Patrick.
Joint Meeting with Doncaster Productivity Committee.

EASTERN COUNTIES **7.30 p.m. FEBRUARY 11th**
The Diocesan Hall, Tower Street, Ipswich.
" Industrial Finishing Technique and Practice (Paints and Organic Coatings)," by W. G. J. Appleton, M.I.Mech.E., M.Inst.F., and J. J. Stordy, B.Sc.

EDINBURGH **7.30 p.m. FEBRUARY 16th**
Chamber of Commerce Rooms, 25, Charlotte Square, Edinburgh 2.
" Suggested Methods of Increasing Production in a Paper Mill," by J. Horsburgh and W. Speirs, A.M.I.Mech.E.

GLASGOW **7.30 p.m. FEBRUARY 17th**
The Institute of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.
" Productivity and the Machine Tool," by N. Stubbs, M.B.E., B.Sc.(Hons.).

GLOUCESTER & DISTRICT
7.15 p.m. FEBRUARY 11th
The Wheatstone Hall, Brunswick Road, Gloucester.
" The Application of Work Study," by G. P. Wade, M.I.Prod.E.
Joint Meeting with the Gloucestershire Engineering Society.

HALIFAX **7.15 p.m. FEBRUARY 1st**
The George Hotel, Huddersfield.
" Productivity in Worm Gear Unit Manufacture," by F. J. Everest, M.Sc., A.C.G.I., D.I.C., M.I.Mech.E., A.M.I.E.E., A.I.Mar.E., M.I.Prod.E.

HALIFAX GRADUATE **7.30 p.m. FEBRUARY 17th**
Collinson's Cafe, Crown Street, Halifax.
Annual General Meeting followed by film " Powered Flight."

LEICESTER **7.0 p.m. FEBRUARY 10th**
Windsor Room, Bell Hotel, Leicester.
Annual General Meeting and lecture " Design and Methods of Manufacture of Portable Electric Works," by C. H. Gubbins, A.M.I.Prod.E.

LINCOLN **7.30 p.m. FEBRUARY 23rd**
The Technical College, Newark.
" Production Control as applied to Small and Medium Companies," by F. T. Hunter, A.C.A., A.C.W.A.

LIVERPOOL **7.30 p.m. FEBRUARY 16th**
The Exchange Hotel, Liverpool.
" Packaging," by A. Frazer Much.

LIVERPOOL GRADUATE **7.15 p.m. FEBRUARY 23rd**
The Stork Hotel, Queens Square, Liverpool.
" Fundamentals of Physical Metallurgy," by T. Fullwood, A.I.M., A.M.I.E.T., C.G.L.I.

LONDON **7.0 p.m. FEBRUARY 24th**
South Eastern Regional Meeting.
The Royal Empire Society, Northumberland Avenue, W.C.2.
" Does the National Certificate in Production Engineering meet the needs of Industry?", by Prof. J. V. Connolly, B.E., F.R.Ae.S., M.I.Prod.E.

LONDON GRADUATE **7.15 p.m. FEBRUARY 16th**
The Institution of Production Engineers, 10, Chesterfield Street, London, W.1.
" Trends and Problems in Milling Metals," by N. Stubbs, M.B.E., B.Sc.(Hons.).

LUTON **7.15 p.m. FEBRUARY 22nd**
North Herts. Technical College, Letchworth, Herts.
" Electronics as an aid to Productivity," by J. A. Stokes, B.Sc., A.M.I.E.E.

LONDON **7.15 for 7.45 p.m. FEBRUARY 16th**
Connaught Rooms, Great Queen Street, London, W.C.2.
Stag Dinner.

LUTON GRADUATE **10.15 a.m. FEBRUARY 19th**
Works Visit to The Lapointe Machine Tool Co., Ltd., Otterspool, Watford By-Pass, Watford, Herts.

MANCHESTER **7.15 p.m. FEBRUARY 21st**
Reynolds Hall (Room C.3), College of Technology, Sackville Street, Manchester, 1.
" Air Photography in Peace and War," by Group Captain F. C. V. Laws, C.B., C.B.E., F.R.P.S.

MANCHESTER GRADUATE
7.15 p.m. FEBRUARY 1st
Reynolds Hall, College of Technology, Sackville Street, Manchester.
" Powder Metallurgy," by Dr. E. M. Trent, M.Met., Ph.D.

NORTH EASTERN **7.0 p.m. FEBRUARY 21st**
Neville Hall, Newcastle-on-Tyne.
" Radioisotopes in Industry," by Dr. H. Seligman, Ph.D.

NORTH EASTERN **FEBRUARY 25th**
Old Assembly Rooms, Newcastle-on-Tyne.
Annual Dinner and Dance.

NORTH EASTERN GRADUATE
7.0 p.m. FEBRUARY 11th
Roadway House, 8, Oxford Street, Newcastle-on-Tyne.
" Vehicle Building," by A. J. Ellis.

NORWICH **7.30 p.m. FEBRUARY 16th**
The Great Yarmouth Technical College, Gordon Road, Great Yarmouth.
" Compressed Air as an Aid to Production," by W. J. Ford, M.I.Prod.E.

NORTHERN IRELAND **7.30 p.m. FEBRUARY 17th**
Lecture Hall, Ulster Farmers' Union, 18, Donegall Square East, Belfast.
" The Machining of Metals," by A. L. Perry, B.Sc. (illustrated by a film).

NOTTINGHAM **7.0 p.m. FEBRUARY 2nd**
Victoria Station Hotel, Milton Street, Nottingham.
" The Measurement and Significance of Surface Finish," by R. E. Reason.

OXFORD **7.15 p.m. FEBRUARY 8th**
The Town Hall, Oxford.
" Management's Responsibility for Productivity," by E. Brewer, B.Sc., A.M.I.I.A.

PETERBOROUGH **7.30 p.m. FEBRUARY 8th**
The Campbell Hotel, Bridge Street, Peterborough.
" Fundamentals of Machine Tool Design," by C. A. Sparkes, M.I.Mech.E., M.I.Prod.E.

READING **7.30 p.m. FEBRUARY 3rd**
The Canteen, Worting Road, Basingstoke.
" Practical Application of Production Engineering Research," by Dr. D. F. Galloway, B.Sc.(Hons.), M.I.Mech.E., M.I.Prod.E., A.M.I.E.E.

ROCHESTER **7.30 p.m. FEBRUARY 10th**
Sun Hotel, Chatham.
" How the Money Moves in Business," by T. G. Rose, M.I.Mech.E., M.I.Prod.E., F.I.I.A.

SHEFFIELD **6.30 p.m. FEBRUARY 14th**
The Grand Hotel, Sheffield.
" The Manufacture of Engineers' Cutting Tools," by C. A. Grayson, M.I.Prod.E.

SHEFFIELD **6.30 p.m. FEBRUARY 28th**
The Grand Hotel, Sheffield.
Informal Meeting.

SHEFFIELD GRADUATE **6.30 p.m. FEBRUARY 28th**
Royal Victoria Station Hotel, Sheffield.
" Machine Control "—The Use of Comparators in Production, by J. D. Richards.

SOUTHERN **7.15 p.m. FEBRUARY 16th**
Polygon Hotel, Southampton.
" Resistance Welding—Its Early History and Modern Development," by Dr. H. G. Taylor, D.Sc.(Eng.), M.I.E.E., F.Inst.P.

SOUTH ESSEX **7.30 p.m. FEBRUARY 16th**
The Mid-Essex Technical College, Chelmsford.
" The Control of Size in Engineering Production," by J. Loxham, F.R.S.A., M.I.Mech.E., M.I.Prod.E.

SOUTH WALES & MONMOUTHSHIRE
7.0 p.m. FEBRUARY 7th
The South Wales Institute of Engineers, Park Place, Cardiff.
" Business Visit to Moscow," by Lord Verulam, M.A., F.I.I.A.

STOKE-ON-TRENT **7.45 p.m. FEBRUARY 18th**
The Town Hall, Hanley, Stoke-on-Trent.
" From Diamond to Spark Machining," by G. Fefer, A.I.Prod.E.

WESTERN **7.30 p.m. FEBRUARY 16th**
The College, Swindon.
" Mechanical Aids to Production," by J. Eric Steel, M.I.Prod.E.

WESTERN GRADUATE **7.30 p.m. FEBRUARY 7th**
The Grand Hotel, Broad Street, Bristol, 1.
Production Brains Trust.

WEST WALES **7.30 p.m. FEBRUARY 11th**
The Central Library, Alexandra Road, Swansea.
" Quality Control " by Dr. B. P. Dudding, M.B.E., Ph.D.

WOLVERHAMPTON **7.15 p.m. FEBRUARY 2nd**
Wolverhampton & Staffordshire Technical College, Wulfruna Street, Wolverhampton.
"Economics in Production Engineering," by Dr. F. A. Wells, B.Sc., Ph.D.

WOLVERHAMPTON GRADUATE
7.30 p.m. FEBRUARY 16th
Wolverhampton & Staffordshire Technical College, Wulfruna Street, Wolverhampton.
"Power Press Characteristics," by Mr. Burton.

WOLVERHAMPTON GRADUATE **FEBRUARY 26th**
Social Visit to Josiah Wedgewood & Sons Ltd., Stoke-on-Trent.

YORKSHIRE **7.0 p.m. FEBRUARY 14th**
The Hotel Metropole, Leeds.
"Work Study," by L. G. Humble, A.M.I.Prod.E.

March 1st to 8th, 1955

BIRMINGHAM GRADUATE **6.30 p.m. MARCH 8th**
The James Watt Memorial Institute, Great Charles Street, Birmingham.
Annual General Meeting and Lecture on "The Use of Air Operated Fixtures in Mass Production," by J. F. Smith, A.M.I.Mech.E., Grad.I.Prod.E.

BIRMINGHAM GRADUATE **MARCH 5th**
Works Visit to Round Oak Steel Works, Ltd.

DONCASTER **7.0 p.m. MARCH 8th**
The Danum Hotel, Doncaster.
"Applications of Rubber to Engineering," by J. P. Holdsworth, B.Sc.(Eng.), G.I.Mech.E.

GLASGOW **7.30 p.m. MARCH 3rd**
The Institute of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow.
Annual General Meeting and Open Discussion.

GLOUCESTER & DISTRICT **7.15 p.m. MARCH 2nd**
The Belle Vue Hotel, Cheltenham, Gloucestershire.
"Modern Methods of Production Control," by E. J. Thomas, A.M.I.Prod.E.
Joint Meeting with the North Gloucester Group of the Institute of Cost and Works Accountants.

HALIFAX **7.0 p.m. MARCH 2nd**
The White Swan Hotel, Halifax.
"Work Measurement Research," by Prof. T. U. Matthew, Ph.D., M.Sc., Wh.Sch., A.M.I.Mech.E., M.I.Prod.E., A.R.T.C., M.I.Chem.E., M.S.I.E.

HALIFAX **7.0 p.m. MARCH 2nd**
The White Swan Hotel, Halifax.
Annual General Meeting.

HALIFAX GRADUATE **MARCH 2nd**
The White Swan Hotel, Halifax.
"Work Measurement Research," by Prof. T. U. Matthew, Ph.D., M.Sc., Wh.Sch., A.M.I.Mech.E., M.I.Prod.E., A.R.T.C., M.I.Chem.E., M.S.I.E.
Joint Meeting with Halifax Senior Section.

LONDON GRADUATE **MARCH 5th**
Works Visit to The National College of Horology, St. Johns Street, London, E.C.1.
Demonstration of modern machines and equipment for instrument and watch making.

MANCHESTER GRADUATE **6.45 p.m. MARCH 2nd**
Reynolds Hall, College of Technology, Sackville Street, Manchester.
Annual General Meeting, followed by film show.
Members' ladies are invited.

NOTTINGHAM **7.0 p.m. MARCH 2nd**
Victoria Station Hotel, Milton Street, Nottingham.
Annual General Meeting followed by films on Production Engineering.

OXFORD **7.15 p.m. MARCH 8th**
The Town Hall, Oxford.
"High Frequency Heating and Brazing," by E. V. Beatson.

PETERBOROUGH **7.30 p.m. MARCH 8th**
The Campbell Hotel, Bridge Street, Peterborough.
Annual General Meeting (Members only), followed by a film show.

SOUTHERN **7.0 p.m. MARCH 4th**
Polygon Hotel, Southampton.
Annual General Meeting.

WOLVERHAMPTON **6.45 p.m. MARCH 2nd**
Wolverhampton & Staffordshire Technical College.
Annual General Meeting to be followed by a demonstration and talk on the applications of Radioactive Isotopes, by F. Scott, B.Sc., A.R.I.C.

YORKSHIRE **7.0 p.m. MARCH 7th**
The Hotel Metropole, Leeds.
Annual General Meeting and lecture.

PRODUCTION APPOINTMENTS

BULLETIN No. 53
FEBRUARY 1955

This bulletin is circulated to all members of the Institution monthly as near as possible to the first of the month. Firms or organisations wishing to insert notices in the bulletin should communicate with the Secretary at 10, Chesterfield Street, London, W.1

The last date for receiving material for insertion in the following month's bulletin is the 20th of each month. The fee for insertion of particulars regarding each appointment is £3 3s. (up to 100 words), and over 100 words £5 5s. A standard charge of £1 1s. per insertion is made to firms affiliated to the Institution, Technical Colleges, Universities and similar organisations.

Advertisers are advised that better response is likely if, in addition to essential qualifications, the following information is given:—

(*a*) Location of appointment; (*b*) Status in the organisation and scope of promotion; (*c*) Salary range and age range.

Advertisers are asked to advise the Institution when vacant appointments are filled. The Institution reserves the right to refuse or withdraw any announcements and also to make any alterations in the wording to ensure conformity with Institution standards.

Members interested in the following appointments should make application in accordance with the terms of notice. No correspondence can be undertaken by the Secretary other than the forwarding of replies to Box Nos.

Mechanical Engineer, Production Engineer and Works Manager required by an important organisation with interests throughout the British Isles and Commonwealth. Remuneration is on the highest scale with excellent prospects. Age not over 45. Full details of qualifications, posts held and salaries to Box No. 983, I.Prod.E., 10, Chesterfield Street, London, W.1.

Senior Sales Engineer required as assistant to Sales Manager. Must be experienced in technical sales correspondence, estimating and tendering for engine driven equipment. Apply in writing to Russell Newbery & Co. Ltd., Essex Works, Dagenham, Essex.

Chief of Progress with knowledge of machine loading and progressing jobs throughout required for large light engineering shop. Five-day week. Good salary to right man. Apply: Sterling Engineering Co. Ltd., Rainham Road South, Dagenham, Essex.

Time Study Engineers required for engineering company, covering the manufacture of electrical and mechanical components. Sound knowledge of machine shop practice and modern methods necessary. Good salary to right men. Five-day week. Staff canteen facilities. Apply: Sterling Engineering Co. Ltd., Rainham Road South, Dagenham, Essex.

Chief Planning Engineer. Applications are invited for the position of Chief Planning Engineer by well-known manufacturing electrical engineers in West London. Candidates must have sound experience of the following: Process planning for batch and mass production from raw material to finished assembly, time study and motion economy applied to light assembly work, factory lay-out for efficient batch and flow line production. Knowledge of press tool and fixture design an advantage. Candidates should hold high technical qualifications in Mechanical, Electrical and Production Engineering. Senior appointment carrying appropriate salary according to qualifications and experience. Write stating full details of experience and salary required to Box No. 1006, I.Prod.E., 10, Chesterfield Street, London, W.1.

Time Study Engineer required by James Neill & Company (Sheffield) Limited, Napier Street, Sheffield 11, to take responsibility for production control office concerned with manufacture of " eclipse " permanent magnets, chucks and magnetic devices. Latest techniques using synthetics for rapid determination of work values employed. Applicant would be expected to extend existing basis, maintain system for incentive bonus payments and ultimately to assist Production Manager in planning production programmes. Generous pension and insurance schemes. Salary according to age and experience. Applications should be addressed personally to Mr. Philip Neill, stating full details of age and experience, with qualifications if any.

Assistant Production Engineers. Dowty Hydraulic Units Ltd., Ashchurch, nr. Tewkesbury, invite applications for positions as Assistant Production Engineers from Graduates and Associate Members of not more than 35 years of age. The organisation is an expanding one and has an interesting and varied programme of new projects. The vacancies are permanent and progressive and offer considerable scope to the right men. Applications should be addressed to the Personnel Manager and should state previous training, experience and present salary.

Chief Production Process Engineer. D. Napier & Son Ltd., invite applications for the post of Chief Production Process Engineer in their London group of factories engaged on the development of aero gas turbines and high speed diesel engines. The successful candidate will be responsible for all manufacturing processes, including facilities for short run development manufacturing. He will be required to control and co-ordinate the activities of the planning, jig and tool, and manufacturing development departments, and plant drawing office. Applications should be addressed to the General Manager, D. Napier & Son, Ltd., Dept. C.P.S., 336/7, Strand, W.C.2.

Senior Work Study Engineers are required by the English Electric Company Limited at Stafford, for product and manufacturing development in the following product groups:— heavy electrical machines; high voltage switchgear; instruments, meters and relays. Applications are invited from engineers with a sound background of practical engineering in a manufacturing industry, together with technical qualifications to at least O.N.C. level. Please write quote Ref. 1225D, to Dept. C.P.S., 336/7, Strand, W.C.2.

Experienced Industrial Engineers. Management and Industrial Consultants have vacancies on their senior staff for experienced industrial engineers who have held responsible executive positions and possess a good knowledge of management problems generally. Vacancies also exist for engineers with production and work study experience to train for consultancy work. These positions involve travelling and working in any part of the United Kingdom. Applicants must hold a university degree or membership of a professional Institution. Applications giving age, details of education, qualifications, experience and other relevant information to Managing Director, Industrial Administration (R. & A.), Ltd., Broadmead House, 21, Panton Street, London, S.W.1.

Senior Planning Engineer to take charge of planning section engaged on armament work. Should be conversant with processing, scheduling, ratefixing and shop loading of machine, fitting and assembly shop work. Liaison with sub-contractors, Ministry and Service personnel will be necessary. Senior staff appointment with comprehensive pension schemes. Apply, giving details of experience, etc., to Personnel Manager, The Bristol Aeroplane Company, Aircraft Division (Weston Factory), Oldmixon, Weston-super-Mare.

Methods Engineers required by Black & Decker Limited, Harmondsworth, Middlesex (near London Airport). Experience of work measurement, methods study, tool design and plant layout for machining, winding and assembly processes as applicable to the large batch production of F.H.P. motors or similar products, essential. Generous salary offered to experienced men; 5-day week (37½ hours). Write full details of age, practical and technical experience and present salary to Personnel Manager.

Senior Planning Engineer required by The de Havilland Engine Company Ltd., to take charge of their sheet metal factory planning department. Applicants should have had experience in a similar capacity, or as deputy or section leader, and must be experienced in the wide range of trades and techniques applied to gas turbine sheet metal components. Please state age and full details of training and experience in chronological order. Written applications only to The Personnel Officer, The de Havilland Engine Company Limited, Leavesden Aerodrome, Near Watford, Herts.

Senior Jig and Tool Draughtsman is sought by a prominent engineering company in the North Midlands. The post has great prospects for development and should be of immediate appeal to a capable young draughtsman who prefers doing independent work. The Company looks for evidence of a practical progressive career preferably with experience of heavy and medium modern machine tools. Please reply giving details of age, experience, etc., to Box No. 1007, I.Prod.E., 10, Chesterfield Street, London, W.1.

Works Manager required by Black & Decker Limited, Harmondsworth, Middlesex. Post can be adequately filled only by a man having personality, first-class education to University graduate standard, a technical background and previous factory experience. Responsibilities include the control and co-ordination of all the manufacturing facilities, all plant and equipment and production control. Only applicants capable of commanding a substantial salary need apply to Personnel Manager.

Works Manager required by leading cosmetic manufacturing company producing high quality preparations of world wide repute. The factory is in the South Wales area and the appointment is an important one, covering responsibility for the complete operation of the factory; the successful applicant must have the ability to organise and develop output of both existing and new products on a rapidly increasing scale. He must have had sound experience of factory management and be able to weld together the existing team of laboratory chemists, production chemists, assembly supervisors, and the purchasing and planning departments, into a well-knit team, and have the drive and imagination to develop new and improved methods to give more efficient production. The greater part of the work is on the assembly side which is largely done on conveyor belt principles. Production engineering experience, therefore, would be a great asset. A four-figure salary, with excellent prospects will be offered to the right man. Box No. 1022, I.Prod.E., 10, Chesterfield Street, London, W.1.

Work Study, Time Study, Layout and Planning Engineers. Sentinel (Shrewsbury) Limited require the services of Work Study, Time Study, Layout and Planning Engineers in their production department. These posts carry good salaries and a pension scheme is in operation. Applications which will be treated in strict confidence should state age and give full details of education, training and experience with dates and should be addressed to Production Manager, c/o Sentinel (Shrewsbury) Ltd., Shrewsbury.

Jig and Tool Draughtsmen. Cyril Adams & Co. Ltd., 155, East Barnet Road, New Barnet, Herts., have several vacancies for jig and tool draughtsmen. Excellent conditions, wages and prospects. Write, or telephone Barnet 2335, for an appointment for an interview.

Special Purpose Machine Designers. Cyril Adams & Co. (Special Projects) Ltd., 70/74, City Road, London, E.C.1. (between Moorgate and Old Street Underground Stations) have several vacancies for special purpose machine designers. These are senior staff appointments and carry appropriate salaries. Applications should be made by letter, stating age, experience and qualifications.

Tool Designers. F. Perkins Ltd., Peterborough, have a number of openings at their Bedworth, Coventry, office, for tool designers for work on special purpose machine and fixture design. Preferred qualifications: full works apprenticeship, experience preferably in the automobile field. These are attractive and permanent positions, especially for young men in their twenties who are looking for further experience and prospects. Please apply in confidence stating age, experience and education in chronological order to: Personnel Manager, F. Perkins, Ltd., Eastfield Factory, Peterborough.

Checker required for fixture and tool design for quantity production of vehicle engines. This is a permanent position for which applications from men with long experience in the design and/or manufacture of tools and above the age of 45 will receive special attention. Please reply stating full details of experience (in chronological order) and salary required to Box No. 1008, I.Prod.E., 10, Chesterfield Street, London, W.1.

Superintendent. Messrs. Fawcett, Preston & Co. Ltd., Bromborough (a subsidiary company of the Metal Industries Limited Group) invite applications for the post of Superintendent in their fitting and erecting shops. It is desirable that applicants should have had experience of hydraulic press work. The post calls for marked organising ability and drive, and offers good prospects. It carries a good salary and a compulsory pension scheme operates. Please apply, quoting Ref.: 110.S., stating age, experience and present salary to the Group Training and Personnel Officer, Metal Industries Limited, 60, Buckingham Palace Road. London, S.W.1.

Assistant Machine Shop Superintendent required by a large company of electrical engineers situated in S.E. London district. The successful applicant must have a good all round general engineering experience, possess drive and initiative and be capable of controlling male and female labour. Staff appointment pension and bonus schemes after qualifying period. Applications in confidence giving full details of age, experience and salary required to Box 3R N.1022, A. K. Advg., 212a, Shaftesbury Avenue, London, W.C.2.

Work Study Engineer required by general engineering company employing 1,500. Applicants must have first class experience of work study in a modern engineering plant and be capable of the development and management of a work study department. Company's products are varied and range from medium sized fabricated plant to light machine and fitting work. The post is a responsible one and carries a commensurate salary together with excellent bonus and pension schemes. Write stating age and full details of training and experience to General Works Manager, The A.P.V. Company Limited, Manor Royal, Crawley, Sussex.

Design Engineer required to take charge of a section located in Central London area, producing designs for domestic and light industrial wiring accessories, fuse gear, automatic cut-outs, etc. Must be progressive and able to produce original ideas for new lines and improvements to existing lines. Knowledge of manufacturing processes associated with this class of apparatus is essential. This is a progressive position with one of the most substantial and oldest established companies in this business, offering security and the advantage of a pension scheme. Write stating age, qualifications and experience. Box No. 1009, I.Prod.E., 10, Chesterfield Street, London, W.1.

Draughtsmen-Designers wanted to work in Central London area on designs for domestic and light industrial wiring accessories. Previous experience desirable on light current switch, fuse and automatic control gear. This is an opportunity to join a substantial old established company offering security, a good salary to competent men, and a pension scheme. State age, qualifications and experience to The Secretary, The Edison Swan Electric Co. Ltd., 155, Charing Cross Road, London, W.C.2.

Tool Design Staff. A vacancy exists on the tool design staff of a leading engine manufacturer for a man experienced in the design of special purpose machines or fixtures. Preferred minimum qualifications: O.N.C. full apprenticeship and experience in the automobile industry. Please write stating age, experience (in chronological order) and salary required to Box No. 1010, I.Prod.E., 10, Chesterfield Street, London, W.1.

Works Manager is required by light engineering company in Birmingham engaged on small batch production, employing 180 persons. Applicant should have good shop floor experience of machine tools, and ability to organise machine shop, assembly and finishing departments. The position will entail the direction of detailed work of departments through the various foremen, the improvement of methods in conjunction with production engineer, the meeting of production programmes, and the maintenance of discipline in the works. Salary £1,500 p.a. with pension scheme. Reply stating age, education and previous experience in confidence to Box No. 1011, I.Prod.E., 10, Chesterfield Street, London, W.1.

Works Manager required for textile machinery manufacturer in South East Lancashire. Applicants must be fully conversant with modern methods of production and capable of handling labour force of up to 1,500. Age 40 to 45. A modern house to rent is available and a non-contributory pension scheme is in operation. Applicants must state full particulars of qualifications and experience, age and salary required. Consideration will only be given to applications containing all these details. Box No. 1012, I.Prod.E., 10, Chesterfield Street, London, W.1.

Planning Engineer required by textile machinery manufacturers in South East Lancashire. Applicants, age 35 to 40, must have had wide experience of all types of machine tool utilisation and batch production methods, and preferably be members of the Institution of Production Engineers. Applicants must give full particulars of qualifications and experience and state age and salary required. Consideration will only be given to applications containing all these details. Box No. 1013, I.Prod.E., 10, Chesterfield Street, London, W.1.

Estimator capable of preparing tooling estimates, required by leading Machine Tool Company. Applicants should possess a sound knowledge of modern tooling methods, supported by a good practical background. Applications which should include past experience, age and salary required, should be addressed to the Personnel Manager, Box No. 1014, I.Prod.E., 10, Chesterfield Street, London, W.1.

Management Consultancy. Leading group, continuing to expand its activities, seeks additional staff for its consultancy practice. Applications invited from executives possessing a wide experience of industrial organisation, methods and layout in either engineering or process industries. Excellent prospects and adequate remuneration offered to suitable men not exceeding the age of 45. Please send full details and indication of salary requirements to Box No. 111, R. Anderson (Advertising) Co., 14, William IV Street, W.C.2.

Management Consultancy. A well known company is prepared to train a limited number of suitable applicants for ultimate appointments as executives in management consultancy. Applications are invited from men between the ages of 25 and 30 years who wish to take up a career in consultancy. They must be university graduates in economics or engineering, preferably with some industrial or commercial experience; willing to travel home and overseas. Salary paid during training appropriate to qualifications and experience. Please send details and indications of present salary level, in confidence, to Box No. 106 R. Anderson & Company, 14, William IV Street, London, W.C.2.

Engineers for the methods department are required by S. Smith & Sons (England) Limited, at their Cricklewood Works, N.W.2. The work involves the laying out of flow line assemblies, and applicants should have experience both in this type of production, as used in the manufacture of small instruments, and also general machine shop practice. Excellent salaries for the right men. Congenial working conditions. Pension scheme. Profit sharing and production bonuses. Fullest details of experience, age, etc., should be addressed to the Personnel Manager, Ref.: MAI/PLI/74.

Senior Methods Engineers required by the English Electric Co. Ltd., Luton, for work on medium quantity production. Applicants must be fully experienced on one of the following types of work:—(*a*) general machine shop; (*b*) assembly; (*c*) electronic assembly. The posts bear the responsibility for reviewing designs for ease of production, methods planning, estimating and proving methods on production, and call for a

high standard of ability and initiative. These are senior appointments carrying appropriate salaries and housing assistance will be available to the successful applicants from the Greater London area. Applications stating age, experience and qualifications to Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. 1360C.

Works Director. A medium sized company in the North West seeks an experienced mechanical engineer with proved administrative ability to be responsible for the whole of the works organisation. The post carries board status and consequently initiative, drive, sound engineering knowledge, particularly in connection with hydraulic and general engineering and administrative ability above average are essential. Applications, which should be addressed to Box No. 2J. N.6611, A. K. Advertising, 212a, Shaftesbury Avenue, W.C.2, and marked " 110.WD," are invited from suitably qualified men who already hold posts of responsibility.

Production Development Engineer. The English Electric Company Limited, require a fully qualified engineer at their Luton works to take charge of a department responsible for carrying out investigation work into new methods of manufacture in the light electro-mechanical field. The successful applicant must have sound practical training and possess a thorough knowledge of the latest manufacturing methods. This is a senior appointment, providing facilities for practical production research work, carrying a salary commensurate with the responsibilities involved, and with housing assistance if required. Applications, which will be treated in strict confidence, should be addressed to Dept. C.P.S., 336/7, Strand, W.C.2. quoting Ref. 1360B.

Operational Research investigator is required by the British Boot, Shoe and Allied Trades Research Association to study means of obtaining increased economy in the cutting and sorting of leather in shoe manufacture. Much of the work will be of a practical or experimental character and the successful candidate will be required to acquire a working knowledge of leather and its uses in shoe manufacture. An aptitude for experimental work and some experience of the application of scientific methods to the investigation of industrial (or service) problems are the essential requirements. Starting salary in the range £750-£1,000. Additional information will be sent on request. Apply to Director of Research, Satra House, Rockingham Road, Kettering, Northants.

Apprenticed Engineers. Cincinnati Milling Machines Ltd., require the service of two apprenticed engineers, aged 25 to 30 years, to demonstrate and service centreless grinding machines. Training will be given, if required, to suitable applicants provided that they have prior experience of the assembly or operation of such machines. Apply in writing for further information to Woodlands Farm Road, Tyburn, Birmingham 24.

Air Compressor and Ancillary Equipment Design Draughtsmen required by well-known Midland firm, on interesting development work. Applicants must be H.N.C. standard or equivalent. Good salary with bonus scheme. Apply in confidence, giving age, qualifications, experience and salary expected to Alfred Bullows & Sons, Ltd., Long Street, Walsall, Staffs.

Planning Engineers required. Applicants should have thorough knowledge of production engineering and be familiar with machining, and jig and fixture design. Good prospects. Staff pension in operation. Apply Personnel Department, Vickers-Armstrongs Ltd., South Marston Works, Swindon.

Senior Production Methods and Development Engineer required by large textile engineering company in Lancashire. Experience in the manufacture of small and medium precision components desirable. Age group preferably 30/40. Salary in the region of £1,000/£1,300. Non-contributory pension scheme available. State qualifications and experience to Box No. 1015, I.Prod.E., 10, Chesterfield Street, London, W.1.

Industrial Consultants or Engineers with considerable experience in production planning, work study and production control and who are University Graduates, are invited to apply for a position on the senior production staff of a well known company with several factories in the Midlands and abroad. This is a high-level appointment and will carry a salary from £1,500 to £2,500, depending upon experience. There will be opportunities for advancement to top-level managerial positions within a few years. Age limits 25 to 40. There is a good pension scheme. All applications will be treated in strict confidence and should state age, qualifications and experience. Box No. 1016, I.Prod.E., 10, Chesterfield Street, London, W.1.

Engineers. Applications are invited from engineers aged approximately 25/30 years, who are looking for a position of advancement and who have had experience in methods engineering and jig and tool design. Applicants must hold National or Higher National Certificates or equivalent qualifications. The works are situated in South West England and are expanding. Salary will be based on experience and qualifications. Please give full details of age, experience, etc. Box No. 1017, I.Prod.E., 10, Chesterfield Street, London W.1.

Planning Engineers required with experience of aircraft repair, overhaul and conversion on civil and military aircraft. Applicants must have had a sound all-round experience on the above work and be conversant with up-to-date production control methods as applied to this type of work. Apply in writing to Personnel Manager, Field Aircraft Services Ltd., Croydon Airport, Croydon, Surrey.

Production Manager of outstanding ability is invited to join the rapidly expanding Solartron Electronic Group Limited. Leadership, initiative and ability as an organiser are of prime importance. Experience of controlling production of complex products in small batches and some knowledge of electronics are essential. This appointment offers an opportunity for an outstanding man to justify a four-figure salary with substantial prospects. Please write to the Personnel Manager, The Solartron Electronic Group Limited, Queens Road, Thames Ditton, Surrey.

Young Engineer Required for operation planning in works of old established engineering firm. Modern factory in country district of Yorkshire. Batch production—light/medium machines. Assistance with housing for satisfactory applicant. Apply with full details to Box No. 1018, I.Prod.E., 10, Chesterfield Street, London, W.1.

Methods Engineer required by old established firm of international repute for light and medium machines and mechanisms. Modern factory in Yorkshire with excellent conditions. Assistance with housing for applicant proving satisfactory. Apply Box No. 1019, I.Prod.E., 10, Chesterfield Street, London, W.1.

Chief Production Engineer. An important company producing medium/heavy electrical gear wishes to appoint a Chief Production Engineer, based on London, and controlling the production engineering function of several works in Southern England. A first class man, with good training and experience, imagination, and the ability to lead a team is needed. This is a top-level appointment, for which a substantial salary will be paid. Applications in full detail should be addressed to Box No. 1020, I.Prod.E., 10, Chesterfield Street, London, W.1.

Graduate, mechanical engineering, required for training in automatic glass manufacture. Excellent prospects for young man, aged 24-28 years, who wishes to train for managerial position in this industry. Contributory pension scheme. Apply giving full personal particulars to Personnel Department, James A. Jobling & Co. Ltd., Wear Glass Works, Sunderland.

Estimator required for price control department for analysis and costing of all design changes. Applicants between 30 and 45 years of age should be conversant with the machining and assembly of hydraulic units. A knowledge of Ministry modifications procedure would be an advantage. The Company offers excellent working conditions, assistance with house purchase after a probationary period and a realistic pension scheme. Write fully in tabulated form to Personnel Manager, Dowty Equipment Limited, Arle Court, Cheltenham, Glos.

Chief Production Engineer. Applications are invited for the appointment of Chief Production Engineer to a large engineering company in the London area. The Chief Production Engineer will be responsible to the Works Manager for:—The planning of production methods and tooling for all new production including liaison with design and development departments at the design stages. A constant review of the methods and tooling of long term production items. The organisation and direction of the work of the production engineering department, which is staffed by some 40 engineers and draughtsmen, including process

planning, ratefixing and jig and tool design staff. Applicants should have had at least 15 years experience in the engineering industry, with a concentration on the production engineering phase, preferably with organisations whose products include light to medium heavy engineering, on varying batch production. Previous experience in a senior production engineering capacity is essential. Membership of a recognised Institution would be regarded as an asset. Commencing salary of the order of £1,300 per annum. Applications giving full details of age, experience, qualifications and present salary to Box No. 1021, I.Prod.E., 10, Chesterfield Street, London, W.1.

Methods Engineer. Age about 25-30, to be responsible to the Production Engineer for process development and work simplification in a company manufacturing a wide and interesting range of precision aircraft equipment and air compressors in batch production. The applicant should have enthusiasm for the technical aspects of production, and should have a recognised apprenticeship with drawing office experience, and H.N.C. including workshop technology preferably with endorsement in industrial administration. Sound knowledge of work study required. Please write with full particulars to the Personnel Officer, The Hymatic Engineering Co., Ltd., Redditch, Worcestershire.

Senior and Junior Planning Engineers required for oil engine division. Workshop experience and jig and tool design knowledge essential. Good salary and prospects for right men in rapidly expanding division. Apply: Labour Manager (S) Rolls-Royce Limited, P.O. Box 31, Derby.

Deputy Chief Production Engineer required by well-known Electronics Company in West London district. Applicants should have engineering qualifications, and experience of flow line production, factory layout and preferably some supervisory experience. Please write in confidence giving age, experience, qualifications and salary required to Box No. 1023, I.Prod.E., 10, Chesterfield Street, London, W.1.

Draughtsman, Plant Layout required by Ultra Electric Limited, Western Avenue, Acton, W.3. Previous experience is necessary, preferably in connection with mass production of electrical instruments. Progressive and permanent position. Pensionable. Good opportunity for the right man. Applicants are requested to write in strict confidence to the Personnel Manager for interview, giving full details of age, experience and salary required.

Young Qualified Production Engineer. Rolls-Royce Oil Engine Division require immediately a young qualified production engineer, experienced in plant layout. A knowledge of work study would be an advantage. Excellent working conditions, staff pension schemes and welfare amenities available. Apply giving age, qualifications, experience and salary required to the Labour Manager (I) Rolls-Royce Limited, P.O. Box 31, Nightingale Road, Derby.

Planning and Estimating Engineer required by rapidly expanding engineering company manufacturing own specialised products in Sussex. Write stating full technical and practical training and experience to Box No. 1024, I.Prod.E., 10, Chesterfield Street, London, W.1

Technical Sales Representative for London area, wanted on commission basis, by well known manufacturers of mechanical handling plant, conveyors, trucks, stillages, etc. State full experience, age, etc., to Box No. 1025, I.Prod.E., 10, Chesterfield Street, London, W.1.

Technical Sales Representative for mechanical handling equipment, Yorkshire area. Commission only (generous basis). Send full details, experience, etc., to Box No. 1026, I.Prod.E., 10, Chesterfield Street, London, W.1.

EDUCATIONAL APPOINTMENTS

Paddington Technical College

Assistant Grade B. Assistant Grade B to be responsible for engineering workshops and to teach C. & G. subjects to Final C. & G. Certificate in Machine Shop Engineering (Theory and Practice). Salary scale £561 x £25—£946 commencing and maximum according to qualifications and experience. Application forms from Secretary at College, Saltram Crescent, W.9, returnable by 21st February (1683).

Hackney Technical College

Assistant Grade B, (September 1955.) Assistant Grade B to teach machineshop engineering to Final C. & G. standard. Machine tools and metrology to H.N.C., to assist with O.N.C., engineering drawing. Good workshop experience essential, teaching experience desirable. Minimum qualifications first-class Final C. & G. certificate or equivalent. Burnham (F.E.) salary scale £561 x £25—£982 commencing and maximum salary according to qualifications and experience. Application forms from Secretary at College, Dalston Lane, E.8. To be returned by 18th February, 1955.